Light and Lighting

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Contents

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South Bank Exhibition

NEXT month the South Bank Exhibition is due to open as part of the Festival of Britain. There have been many expressions of opinion as to the time and place of this exhibition, as, indeed, there were concerning the Great Exhibition in Hyde Park a century ago. We are unconcerned with these, but, like many of the public, we have great expectations of the present exhibition, though our special interest lies in the lighting of it. In this issue of the Journal we publish a "preview," based upon authoritative information, though, in common with our readers, we must await the completion and opening of the exhibition before we shall know whether—as W. S. Gilbert wrote of the sun—"its rays are all ablaze with ever living glory." Lighting is of the essence of any exhibition and, in this case, should itself be an exhibit exemplifying good practice—for which no country has more "know how" than our own. Such spectacular features as the illuminated "skylon" will doubtless attract attention, but it is to the lighting of the interiors of the exhibition buildings and of the grounds that we shall look with the greatest interest.

Notes and News

Instruments or Instinct

On Wednesday, February 28, the Illuminating Engineering Society held one of its successful informal meetings when a number of members aired their views as to the relative merits of measurements and of aesthetic judgment when forming an opinion of a lighting scheme. Mr. J. G. Holmes was in the chair and the protagonists on the two sides were Mr. H. G. Campbell, who favoured instruments, and Mr. J. Bickerdike, who urged the claims of instinct. They were supported respectively by Mr. R. R. Holmes and Mr. T. O. Freeth.

A number of speakers tended to confuse the issue to some extent by directing their attention to the *design* of lighting schemes rather than their *assessment*. Mr. Bickerdike, for example, was very emphatic that no one could evolve a scheme by the use of instruments, and his supporter, in a very witty speech, insisted that, while the engineer could tell the designer the amount of light needed and the mechanical means by which it could be produced, it was solely for the artist to evolve the design and "his aesthetic instinct should be all-conquering."

It was left to Mr. A. W. Jervis to bring the discussion back to the subject of assessment, possibly because his own work was, as he explained, so frequently judged by the instinct of the person for whom it was designed, viz. the customer. In the fitting room, a costume is judged not so much by how it appears itself but by how the potential purchaser appears when wearing it, and this is a thing that no instrument can measure. A somewhat similar line of argument was followed by Mr. Cunnington, who said that the instrument, while very useful in its own sphere, missed all the subtleties which often had a great share in determining the success or failure of a lighting scheme. He instanced the installation in the new House of Commons, which, he said, was perfect as far as measurements went but which was by no means satisfying to everybody.

The general conclusion seemed to be that both instruments and instinct had their own parts to play both in design and in assessment; the instrumentalist and the artist were both necessary and should be partners. As Mr. Bickerdike put it in his remarks at the end of the meeting, the illuminating engineer had to deal with people and it was the assessment made by those people that really mattered. The instrument's part was to place on record the standard of assessment thus arrived at. A somewhat similar view had been expressed earlier by Mr. Imrie-Smith when he made the remark that experience should never be used for

Next I.E.S. Meeting in London

The next I.E.S. Sessional meeting in London will take place at the Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, at 6 p.m., on Tuesday, April 10. The paper to be presented is entitled "Recent Developments in Gas Street Lighting," by P. Crawford Sugg.

The paper will detail the improvements and changes which have been made in low pressure gas street lighting since the end of the war and will show how maintenance has been simplified and improved performance and consistency of operation achieved.

precise duplication ; it should serve as an analogy to be adapted as required.

A number of other points were brought out in the discussion. For instance, it was well said that, while the final assessment might be by instinct, instruments could be used to narrow the range within which the assessment had to be made.

Perhaps one of the most interesting features of the discussion was the nature of the views expressed by well-known members of the illuminating engineering profession. Quite apart from the four opening speakers (who may well have spoken sometimes rather from their brief than from their conviction) the claims of instinct were strongly upheld by Mr. Howard Long and its importance as a partner of the instrument by Mr. Hubble, Mr. Souter, Dr. Hopkinson and others. The subject was clearly an excellent choice for an informal meeting and the Society is to be congratulated on bringing home to its members once again the fact, which cannot be too often emphasised, that illumination is an art as well as a branch of engineering.

I.E.S. Dinner

The I.E.S. annual dinner, which since the inception of the Summer Meetings has been held on alternate years in London and in the provinces, is always a most enjoyable and popular function. This year it is to take place on May 9 at the Café Royal and details have been circulated to I.E.S. members.

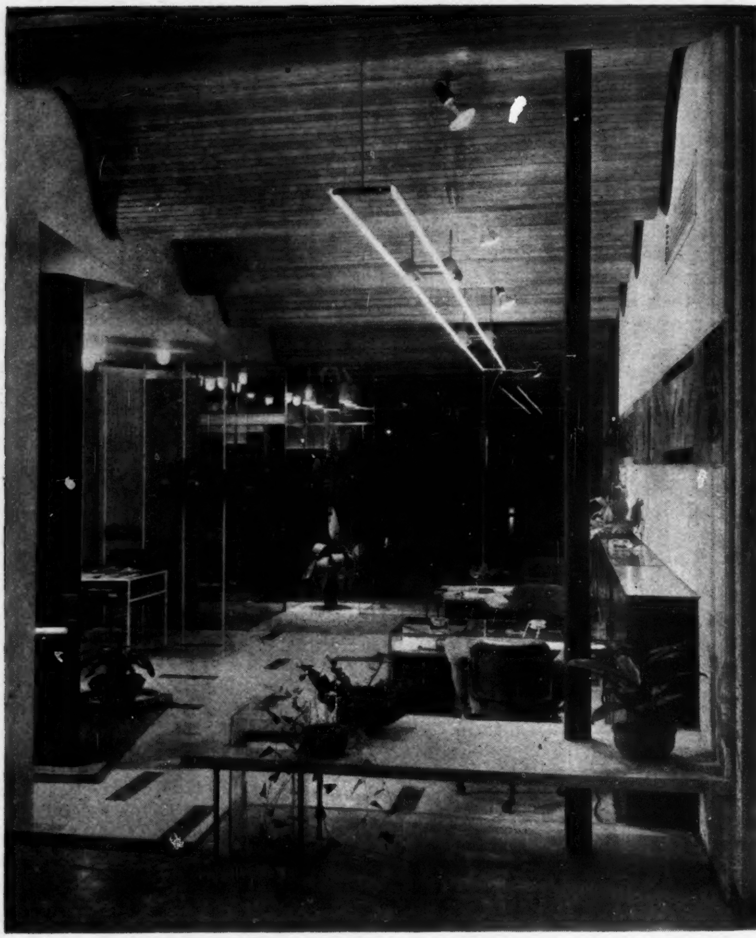
It is understood that the principal guest on this occasion is to be Sir Gerald Kelly, President of the Royal Academy. Sir Gerald, we believe, has quite definite views on the importance of lighting in both the execution and the display of works of art. The subject is not one which has been altogether ignored during recent years, work has been carried out at the National Gallery, at the B.R.S., and at Birmingham, but the views of the P.R A. himself will be well worth having. The I.E.S. is getting quite a reputation for seeking the other man's point of view; this latest effort is most commendable.

Ideal Homes

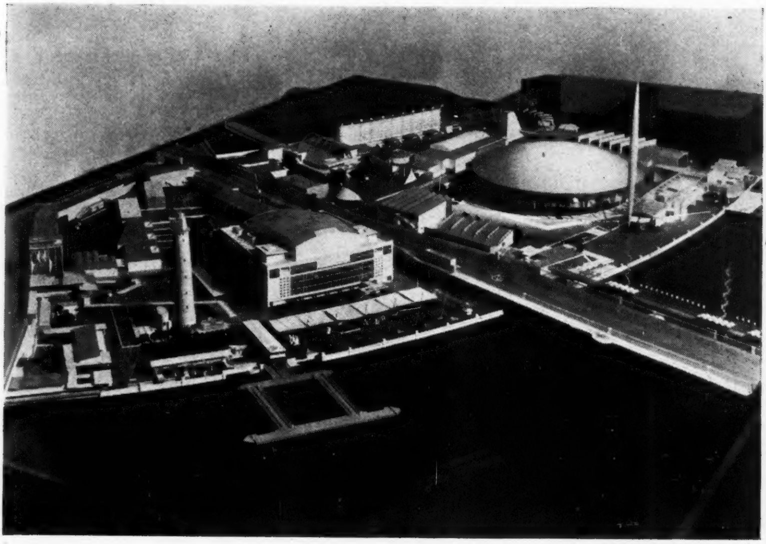
The Ideal Home Exhibition at Olympia always entices us away from our desk and after a fairly quick glance at the stands we always make for the "Village of Ideal Homes." During the last few years there has, in our opinion, been a progressive improvement in the equipment and furnishings of the houses and we are thankful to see that some of the more revolting designs and layouts of a year or two back have now given place to things with which it would be quite easy to live.

We were particularly interested in the lighting of the houses, but here we had some difficulty in deciding what fittings would be part of the house as built and what had been put in just for exhibition effect—and it was useless asking questions because no one seemed to know anything about the lighting. However, we noticed that, except in the kitchens and one lounge which boasted a diminutive chandelier, there were no ceiling fittings and reliance was placed almost entirely on local lighting points. It may, of course, have been easier this way for purposes of the exhibition. In one house we were told that the pelmet lighting (rather badly done) was simply to give a daylight effect and was not intended as a fixture, though with very little extra effort it could have done all this and have looked very much neater.

In another house every room had fluorescent cornice lighting but the cornices were only about two inches from the ceiling so that changing the lamps would mean ripping out the whole cornice. The furnishing of all these houses has been arranged by members of the staff of the "Daily Mail" and in this particular case no mention of lighting is made in the catalogue write-up; it is quite possible therefore that our informant who said the cornice lighting was for exhibition purposes only was quite right—but without it things would have been mighty dim.



View of the interior of a new London travel bureau where unusual lighting treatment has been applied to conform with the architectural features.

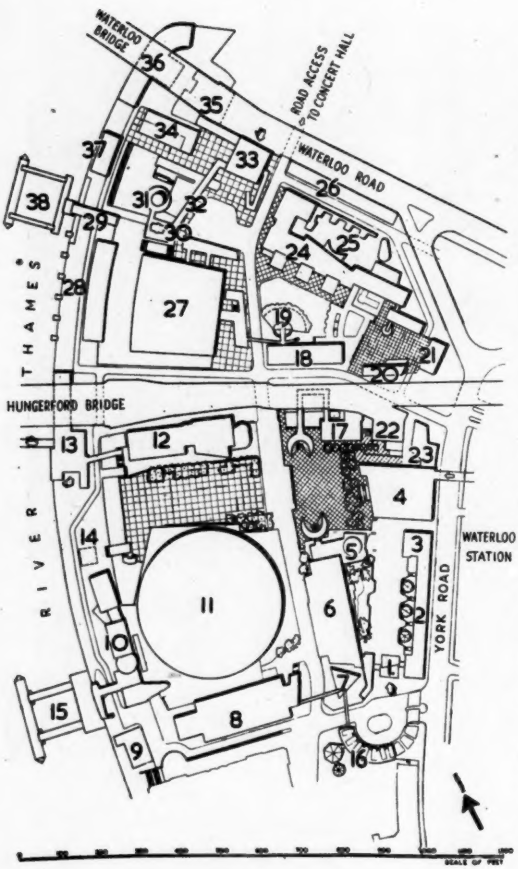


Preview of the SOUTH BANK EXHIBITION

The following article describes the exterior lighting at the South Bank Exhibition which is the centre-piece of the Festival of Britain.

Lighting is an important factor in any exhibition, and with one such as the South Bank Exhibition, organised in connection with the Festival of Britain, where the exhibition covers such a large outdoor area and where it is intended that the exhibition shall remain open during at least part of the hours of darkness, the lighting is of the utmost importance.

To cover the lighting of such an exhibition in one go would be impossible, at any rate as far as the lighting engineer is concerned. The plan is, therefore, to deal with it in two parts: firstly, by giving a preview of what is being done, to indicate the problems which the lighting engineers and designers have set themselves or have otherwise had to overcome; and, secondly, to present a more pictorial account of the exhibition after it has opened. The following article endeavours to deal with the first part of this plan, but here again the size of the task prohibits more than a mention of some of the more interesting aspects. All the buildings on the exhibition site are unique, and they have all, therefore, tested the ingenuity of the lighting engineer to the extreme. Hardly any lighting application in the exhibition could be described as an everyday task. Therefore, much has been



1. Chicheley Street Gate.
2. Information and Post Office.
3. Fairway Cafe.
4. Station Gate, Escalator Hall, for Underground below.
5. The Land of Britain.
6. The Natural Scene.
7. Minerals of the Land.
8. Power and Production.
9. The 51 (Bar).
10. Sea and Ships.
11. Dome of Discovery.
12. Transport.
13. Regatta Restaurant and Embankment Gate.
14. The Skylon (Vertical feature).
15. Nelson Pier.
16. Administration Block.
17. The People of Britain.
18. The Lion and the Unicorn.
19. The Unicorn (Cafe).
20. Television.
21. Telecinema.
22. Locomotive Exhibit, Turntable Cafe below.
23. Police and First-Aid.
24. Homes and Gardens.
25. Courtyard.
26. Administration and Staff Canteen.
27. Royal Festival Hall.
28. Seaside.
29. Restaurant.
30. 1851 Centenary Pavilion.
31. The Shot Tower.
32. Bridge to Royal Festival Hall.
33. Waterloo Bridge Gate. The New Schools and Design Review below.
34. Harbour Bar.
35. Health
36. Thames-side Restaurant.
37. Sport.
38. Rodney Pier.

left unsaid, but, nevertheless, it is hoped that the following account will be of interest.

This account deals only with the exterior lighting at the exhibition. Though not necessarily all completed at the time of going to Press, it was easier to deal only with the exterior lighting than to include details of the interior lighting of the various pavilions and buildings as had in fact been envisaged at one stage. The interior lighting is mainly a matter of interior display lighting, and it is thought that it can only adequately be dealt with after the interiors have been completed.

The design of the exterior lighting installations was the work of a number of firms in the lighting industry in close co-operation with the architects and designers of the exhibition. Full acknowledgments are given at the conclusion of the article.

The Dome of Discovery

The general appearance and shape of the Dome of Discovery is shown in Fig. 3. The night-time appearance required with this building of such unusual design was that of only a faintly illuminated skirt and walls, with the framework of the supporting struts showing in silhouette. The floor area surrounding the wall of the Dome had to be emphasised by reducing the amount of direct light falling on to the skirt to a minimum, the skirt being lighted mainly by light reflected from the ground. It was

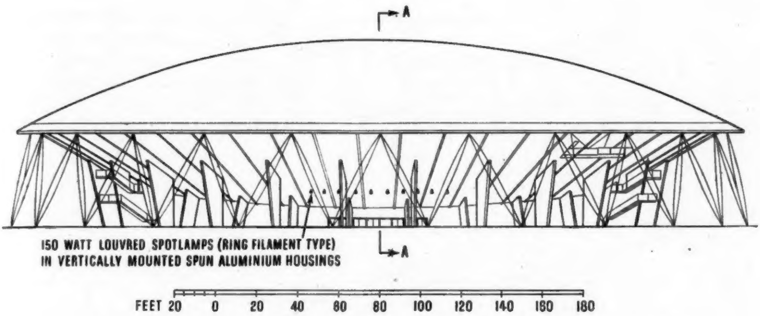


Fig. 3. Drawing showing structure of the Dome of Discovery.

appreciated that such lighting would be inadequate for the entrance steps, where supplementary lighting would be required. Since the whole of the inside of the aluminium skirt would be visible from the interior of the building, the architect insisted that the smooth appearance of the skirt be retained, thus prohibiting the use of recessed fittings. The architect also wished to avoid suspending lighting units from the visible part of the skirt on the outside of the building except over the entrance.

It was decided to light the area surrounding the Dome by means of 150-watt grid-filament spotlights mounted in adjustable units specially designed for the purpose (Figs. 4a and b). These are mounted in groups (Fig. 5) under the eaves of the Dome at the junction of the thrust ring girder and the skirt, thus making them reasonably inconspicuous (Figs. 6 and 7). These units are louvred to control the light distribution and to prevent undue glare. Access to the fittings is provided by means of hinged panels in the skirt of the Dome (Fig. 8), thus facilitating maintenance of the fittings and complying with the requirements of the architect. For the entrance a special fitting was developed from the standard "Edispot" housing to incorporate one 150-watt ring

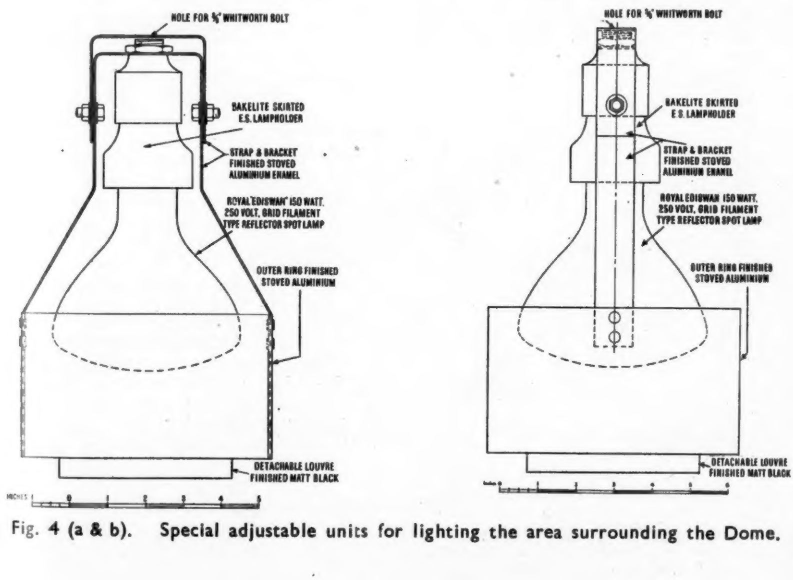


Fig. 4 (a & b). Special adjustable units for lighting the area surrounding the Dome.

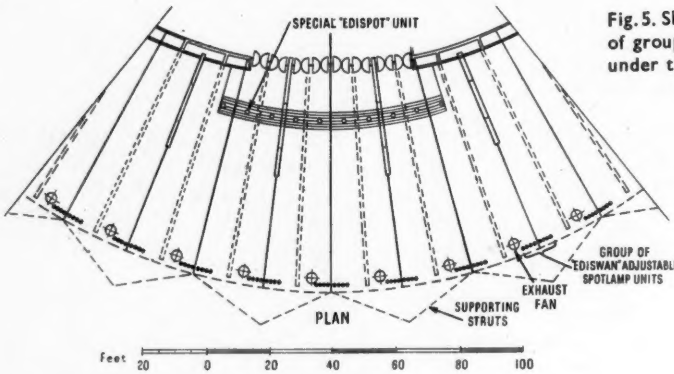


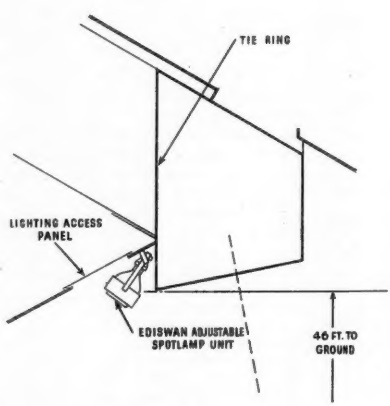
Fig. 5. Showing position of groups of spotlights under the eaves of the Dome.

filament lamp. This fitting also is louvred and is supplied with a special mounting to enable it to be mounted on to the sloping surface of the skirt (Fig. 9).

The exterior lighting of the Dome was carried out by the Edison Swan Electric Co., Ltd., who were also responsible for the exterior lighting of the Sea and Ships building, the Bailey Bridge and the main concourse which are fully described further on in this account.

Sea and Ships

As has already been mentioned, all the buildings are of unusual design and the Sea and Ships building is no exception. It consists basically of a steel framework made



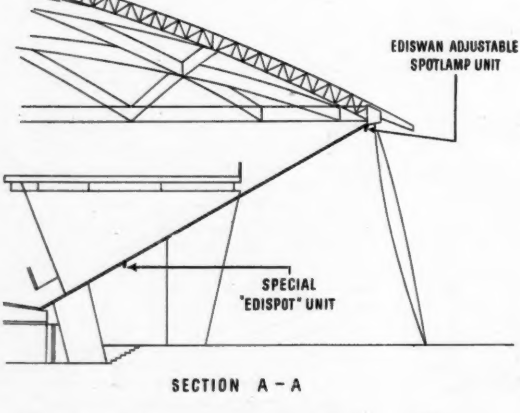


Fig. 6 *(left)* and Fig. 7 *(above)*. Showing concealment of spotlights under the eaves of the Dome.

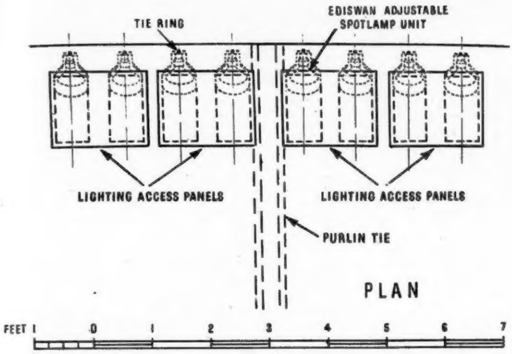


Fig. 8. Showing access panels in the skirt of the Dome.

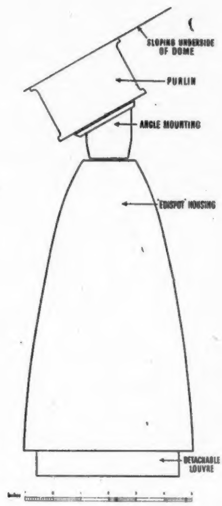
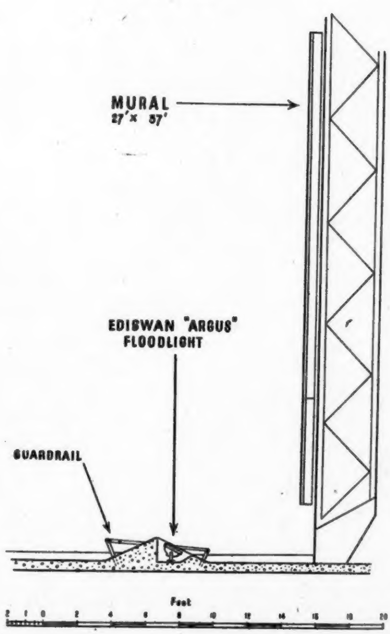


Fig. 9. *(Right)* Fitting used for lighting the entrance to the Dome.

Fig. 10. *(Below)* Lighting arrangement for the mural outside the Sea and Ships building.

up of lattice girders; part of the structure is roofed over and walled to house interior exhibits, but from the exterior the building is essentially a steel structure on to which certain display panels and features have been superimposed. This section of the exhibition also includes some of the river entrances to the exhibition grounds, including a floating pier connected to a landing-stage by means of two gangways of somewhat similar structure to the Bailey Bridge which is described later. The landing-stage houses turnstiles, offices, and a tea bar.

The west side of the building, i.e., facing the river, contains three main features, a mural painting measuring 57 ft. by 27 ft., a large 16 ft. dia. coloured disc and a bas relief 40 ft. square. The method adopted for lighting the mural is shown in Fig. 10—eighteen trough floodlights being used. The coloured disc is lighted by means of one 1,000-watt concentrating flood mounted on an adjacent structure. The lighting of the bas relief presented a rather more difficult problem. The method adopted for the mural, i.e., a line of floodlights close to the feature itself, could not be used as it would give an effect of distortion due to the shadows cast by the sculptured figures. This feature is therefore to be lighted by twelve 500-watt concentrating floods fixed to a special mounting designed by the architect.



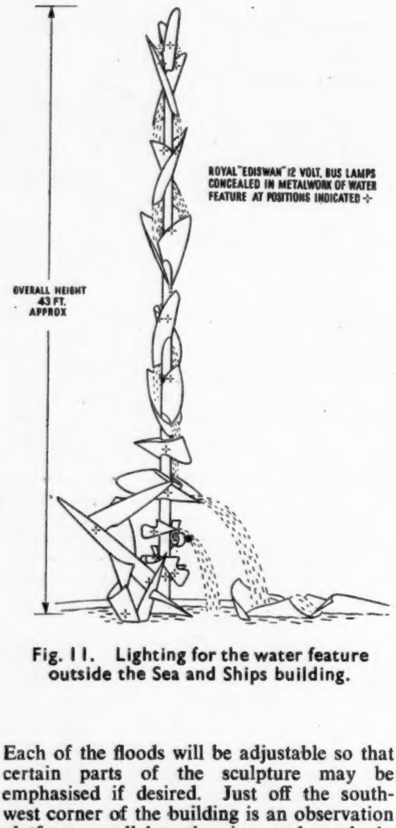


Fig. 11. Lighting for the water feature outside the Sea and Ships building.

Each of the floods will be adjustable so that certain parts of the sculpture may be emphasised if desired. Just off the south-west corner of the building is an observation platform parallel to the river and overlooking the landing-stage and connected to the main building by a bridge. The underside of the platform is lighted by means of 54 recessed lighting units.

Adjacent to the observation platform is a novel water feature which will be recognised by both sight and sound. The feature, which is illustrated in Fig. 11, consists of a hollow vertical stem surrounded by specially designed metal fins and with a number of counter-balanced buckets of various sizes mounted on the lower part of the stem. Water is forced up the stem and emerges from the "tulip" at the top. The water then flows down the outside of the stem, being directed by the metal "leaves" arranged in helical formation around it. The water ultimately falls into the buckets, the filling of which is accelerated by means of direct injection from a water supply near the main base of the feature. As the water-level in each bucket rises the centre of gravity changes until eventually the bucket tips over pouring the water into a series of specially designed metal chutes which cause the water to splash and foam around the base of the feature. The buckets are not synchronised and will therefore overbalance at different times; as the largest bucket holds 100 gallons of water the sudden cataract is quite impressive.

The lighting problem was to emphasise the streams of water flowing down the stem and the flow of water from the tilting buckets. The solution adopted is the use of small lamps concealed in the buckets and in the scrollwork of the metal "leaves" so as to make the water appear self-luminous by total internal reflection. The lamps used are 12-volt pearl bus lamps mounted in waterproof holders and deployed as shown in Fig. 11. Each group of lamps casts a glow of light on the metalwork immediately above it and the overall effect at night is of a broken pattern of light and shadow with the streams of water appearing self-luminous.

The lower part of the south wall of this building is lighted to only a comparatively low intensity by means of twelve concealed trough floodlights. Also on this side is a 20-ft. high statue of Neptune which is lighted by means of three 1,000-watt louvred concentrating floods mounted on a mast. There are a number of other floodlighting applications on the east side, i.e., the side facing the Dome of Discovery. There is also a dome on part of this building; fortunately it is smaller than *the* Dome and it is conveniently picked out at night by twelve 300-watt floods mounted on the roof steelwork. The open steelwork itself is intended to be reminiscent of a shipyard and to retain this impression at night the vertical girders are lighted by 200-watt floods mounted on the frames by means of special gimbal brackets.

The South-East Section

The exterior lighting in this section has been carried out by the B.T.H. Co. As in the remainder of the exhibition, the illumination on the main causeways and fairways is being kept at a relatively low level, so as not to draw attention away from buildings and other special features. Many of the buildings have a large amount of glass in their construction, and will, therefore, stand out well by virtue of their own (interior)

lighting. Exterior lighting is, however, being employed where practicable.

Several of the features are so unusual in character that floodlighting presents considerable difficulty. In particular — and this, of course, applies throughout the site —it is necessary to position the light sources in such a way that they are screened as far as possible from the eyes of visitors at normal angles of vision. With this in mind special louvres are being employed in a number of instances.

The wild garden in front of the Country Building, where nine 1,000-watt floodlights are being placed so as to give general coverage over the whole area, is a typical example of this particular kind of problem. Special effects will be produced here and there by means of 20 150-watt units posted at ground level at selected points.

One of the most dramatic effects is seen at the Natural Resources Building. This consists of a concrete edifice in the form of a truncated tetrahedron with embedded coal. A striking effect is achieved by the use of nine 400-watt mercury vapour floodlights shining on to the facets of the coal, with light rapidly falling off towards the top of the building. Smoke, continuously emitted from the top, is to be lit by three 140-watt sodium vapour lamps, the whole feature being intended to symbolise the coal-mining industry.

Another spectacular structure in this section is the large screen backing on to York Road. The principal function of this is to conceal the bulk of Waterloo Station from view from the Festival Site. It consists of complex geometrical figures built up of tubular steel members from which is suspended canvas in various colours. The whole screen measures some 300-ft. long and is 60-ft. high and a total of 320 150-watt floodlamps are used.

A feature that presented a special problem is a tall flag-mast which is required to have its own floodlighting. Its lack of bulk made it extremely difficult to direct effective light on to it without causing excessive glare to people on the opposite side. The problem has been solved by recessing four 1,000-watt floodlight projectors in shallow pits in the ground at the base of the mast, the beams being aimed directly upwards.

It will be seen that floodlights form the major part of the exterior lighting equipment in this section and where possible standard equipment has been used. One

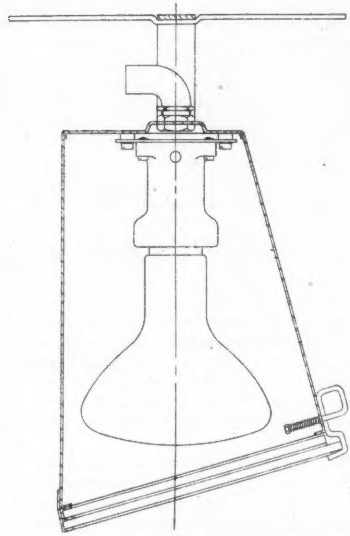


Fig. 12. Sectional drawing of the B.T.H. "Fourteen" floodlight for use with 150-watt lamp.

new floodlighting fitting has been designed for use on the South Bank and elsewhere during the Festival and a section of the fitting is shown in Fig. 12.

The Main Concourse

The main Concourse divides the exhibition grounds into two parts from east to west and extends from the Waterloo entrance down to the main water display adjacent to the river. It is flanked by the Dome of Discovery on the south side and by the Transport pavilion on the north side. The Concourse gives an impression of spaciousness to this part of the exhibition grounds, and the area is broken up somewhat by groups of trees which have been planted and by flower baskets. It was desired to provide a pattern of light over the lower level of the Concourse (see Fig. 13) by means of recessed units and a special fitting was designed for the purpose. The fitting consists of a spun metal canister housing a 15-watt sign lamp and covered by a sand-blasted circular glass front cemented into the top of the fitting. (See Figs. 14 and 15.) A total of 450 of these fittings have been used and are

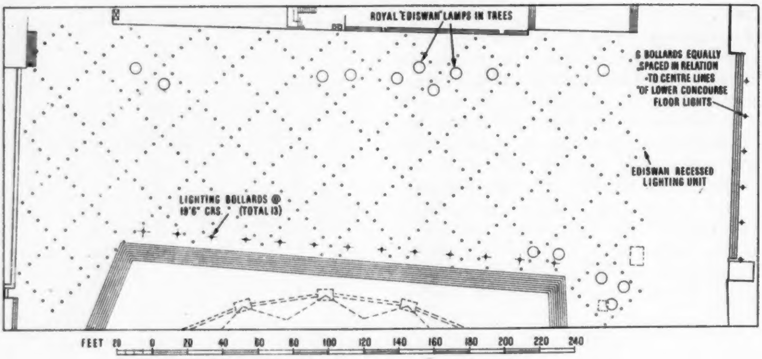


Fig. 13. Plan of Main Concourse.

arranged in a diamond-shaped pattern as shown in Fig. 12.

The steps leading up to the Dome are lighted by means of bollards mounted at the foot of the steps, i.e. below the Dome level so as not to break up the pattern of the Dome when viewed from the Concourse level. The steps leading to the Upper Concourse, i.e. to the east, are also lighted by means of similar bollards, but in this case they can be mounted at the top of the steps.

The majority of the trees are illuminated by coloured lamps in the foliage, and others are floodlighted. The flower baskets are illuminated by special mushroom fittings.

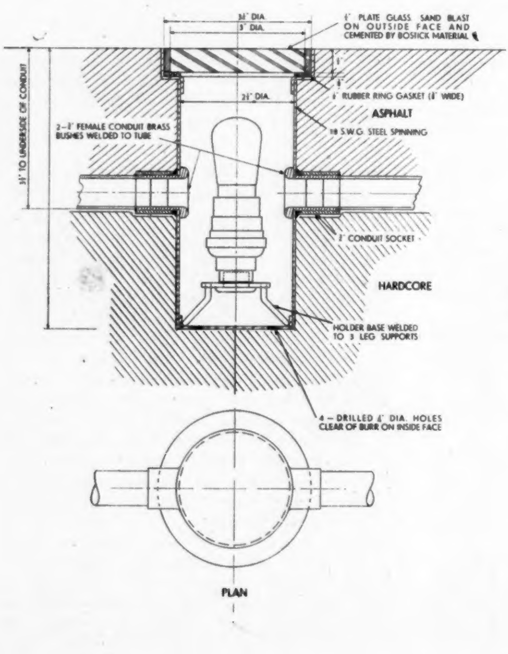


Fig. 14. Drawing of special recessed fitting for lighting the Main Concourse.

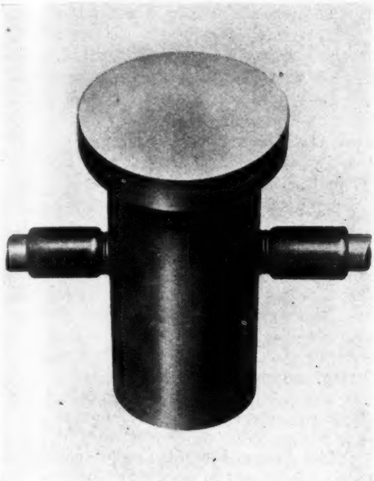


Fig. 15. Photograph of Concourse lighting fitting.

Downstream Riverside Section

In the downstream riverside section, the exterior lighting of which has been carried out by Siemens Electric Lamps and Supplies Ltd., there are no large buildings other than the Royal Festival Hall and, consequently, floodlighting has not been introduced generally. It is probable that grouped floodlight lanterns will be placed at the north-west and south-west corners of the Hall to give an outline for the building when viewed from across the river, but general floodlighting of this building will not be carried out as it would detract from the effect obtained by viewing the brightly illuminated interior through the large window area. These floodlight lanterns will be of parabolic section using 2-kw. and 1-kw. line filament lamps. The object is to have a bright base to the building with a quick fall off towards the top.

In other locations specially designed fittings have been called for, and Fig. 16 shows an indirect cupola lighting fitting which is used for general lighting in the Belvedere Road area, on the Pontoon Landing Stage and also in certain garden areas. Each standard uses a 200-watt G.L.S. lamp.

The garden seating area adjacent to the Riverside Restaurant, the steps leading to this, the viewing platform area near the riverside and the Festival Hall Terrace are lighted by conical masthead floods shown in Fig. 17. These consist of a standard floodlight lantern using lamps from 75 watts to 200 watts, the lantern being inserted in a sheet aluminium cone for fixing either direct to walls or, by means of a clamp, on to masts.

The fairway adjacent to the boat pool will have movement lighting provided by concrete bollards (Fig. 18), having a louvred lighting fitting mounted on top equipped with a 200-watt G.L.S. lamp. These will also be used on the arena viewing level.

There is a school garden in Belvedere Road and this is planted with flowers, etc., according to the time of year. For the night viewing of these gardens a number of "harebell" units (Fig. 19) are used. These vary in height from 18 in. to 36 in. and

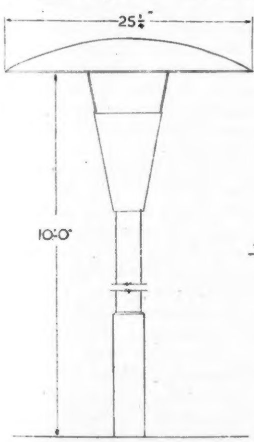
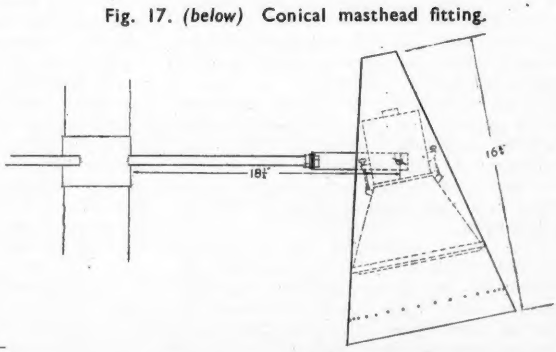


Fig. 16. Indirect cupola lighting fitting.

Fig. 17. *(below)* Conical masthead fitting.



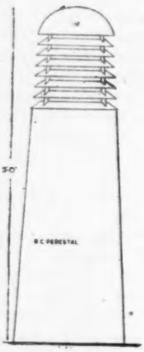


Fig. 18. Illuminated bollard.

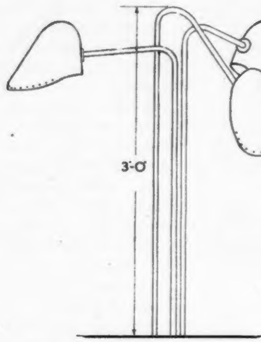


Fig. 19. "Harebell" fitting.

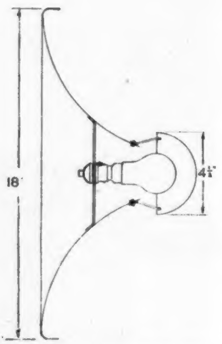


Fig. 20. "Target" fitting.

consist of aluminium "Versalite" reflectors equipped with 60-watt G.L.S. lamps. They are used in the gardens adjacent to the Festival Hall. There are several flower-beds and shrubberies surrounding various restaurants and other buildings in this section, and in these situations small ground-mounted floodlights are used with 60-watt and 100-watt G.L.S. lamps.

On the Shot Tower, starting at a height of eight feet from ground level and in three rows, are fixed a number of "Target" fittings (Fig. 20). These are mainly for effect although a certain amount of diffused lighting will assist the general movement in this area. The Sports Area is floodlit from the underside of the gallery at the top of the Shot Tower by lanterns using 2-kw. line filament lamps.

On the Seaside Terrace flanking the river wall in front of the Festival Hall there are six large canvas valerums, each 48-ft. square, in the form of an inverted cone, and these are illuminated on the underside by eight standard dispersive reflectors each equipped with a 300-watt G.L.S. lamp. In front of the valeria there are six viewing platforms which project over the river wall, and to light the underside of these parabolic angle reflectors of the standard type are used mounted in watertight pits adjacent to the river wall, each equipped with a 200-watt G.L.S. lamp.

The scale model of the Centenary Pavilion, which is next to the Shot Tower, is illuminated by colour-sprayed lamps on festoon strip. To assist movement in various other open spaces standard floodlighting units are being used.

The Down Stream East Area

This area, in which the G.E.C., Ltd., were responsible for the exterior lighting, is intended to provide a somewhat restful contrast to the gaieties in the other areas, and for this reason there are gardens and lawns in the central area with illuminated shrubs and other features.

On the south side of the area is the Character and Tradition pavilion where the main feature for illumination is the group of nine flag-masts on the terrace. The illumination is provided by fittings fixed to the masts above eye level, there being three fittings on each mast. Since these masts are in the centre of an open area, the flags will be seen silhouetted against a dark sky, which will add to the effectiveness of the lighting. The floodlights are contained in conical features which are intended to disguise their purpose in the day-time.

The two masts of the restaurant in this area are also illuminated, in this case by means of high-power floodlights concealed on the roof of the restaurant.

The exterior of the Telecinema, also on the south side, can be seen from the open centre part of this area. It has a dark red wall with metal studs at intervals, and the wall is illuminated obliquely by means of narrow beam floodlights fixed high on the end wall of an adjacent building. The east elevation of the Telecinema is also illuminated by means of floodlights, which in this case are at ground level and directed obliquely at the building. There are some decorative lighting garden features in the area adjoining this face of the building.

On the north side of the garden area is

the Homes and Gardens pavilion, to which is attached an introductory annexe, the exterior walls of which consist of a number of square sections, each of which is, in effect, a very flat pyramid. The four triangles thus formed are painted different shades, and the floodlighting from the ground close to the building is intended to accentuate this difference. The wall at the rear is similarly treated, but in this case the floodlights are on the roof of a convenient building.

On the Belvedere Road end of the Homes and Gardens building proper there is a mural illuminated by upward floodlighting at comparative close offset, concealment being provided by a low wall. On the side of the building facing the garden area are four bays, each of which has a small flower-bed with illuminated shrubs lit by high-power floodlights, which produce an interesting shadow effect on the wall behind. The garden spaces in between these sections of this building are provided with small angle fittings and decorative features for added interest.

At the rear of this building there are various flower-beds which are lit in a similar fashion. Also in this area, but walled off from it, is a camping display, which is floodlit by high-powered floodlights fixed on the roof of an adjacent building, and also by some small angle fittings placed on the ground. This camping display is visible only from the interior of the Homes and Gardens building.

The central area itself, known as the Landscape, consists of a courtyard and a large laid-out garden, and is bounded on three sides by the areas previously described and on the fourth side by Belvedere Road. In the courtyard there are a number of flower-beds with decorative lighting features. The garden area will be lit by small angle units placed on the ground, throwing shrubs into relief against dark mounds of earth which form the boundary of the restaurant moat. In order

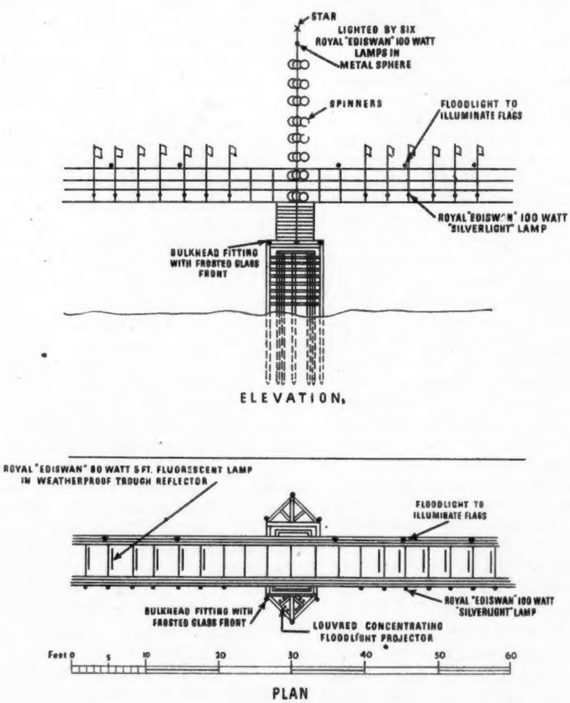


Fig. 21. Showing section of the Bailey Bridge and the lighting arrangement.

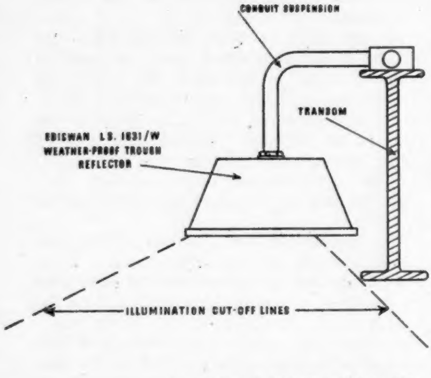


Fig. 22. Showing mounting of fluorescent lamps on main footway of the Bailey Bridge.

to indicate a passage for traffic a double line of bollards is situated between the courtyard and the Telecinema.

The north-east corner of this area, bounded on the north side by the Administration Building and on the east side by a footpath leading to Hungerford Bridge, has two interesting features. One is the decorative screen which has been erected along the boundary wall by the footpath. This screen consists of fibrous plaster spheres painted with bright colours, suspended on a system of wires by tall masts fixed to the boundary wall. The screen is floodlit by means of high-powered floodlights fitted with spreader glasses fixed to the masts. The whole of this lighting can be continually changed in intensity by means of a motor-driven dimmer. On the supporting masts there are a number of small fittings similar to those used for mast lighting outside the Character and Tradition pavilion; in this case they are used for lighting the roadway and exit.

Another interesting feature in this area is the flag-mast on the roof of the Administration Building. Twenty floodlights have been fitted around the base of the mast in pairs; they are connected with a mechanism which flashes the lights on and off alternately and this gives an impression of animation to the feature.

The Bailey Bridge

The general arrangement of part of the bridge, which is carried on six piers piled into the river bed, is shown in Fig. 21. A steel mast is mounted on the upstream side of each of these piers, the masts carrying multi-coloured spinners which revolve in the wind. Each mast is surmounted by a white painted star. The upstream side of the bridge carries 66 flag-masts and there is a service walkway bracketed off the downstream side of the bridge.

There were three distinct lighting problems in connection with the bridge. First there was the main footway itself, which is over 1,000 ft. long, and here it was thought that the lighting should endeavour to break up the monotonous regularity of the steel structure. There was also the service walkway to be lighted to allow safe movement without distracting from the lighting of the main footway. There was also the decorative lighting of the bridge, i.e., the spinners and stars on the masts and the flags on the upstream side, all of which had to be illuminated without causing glare to people on the bridge.

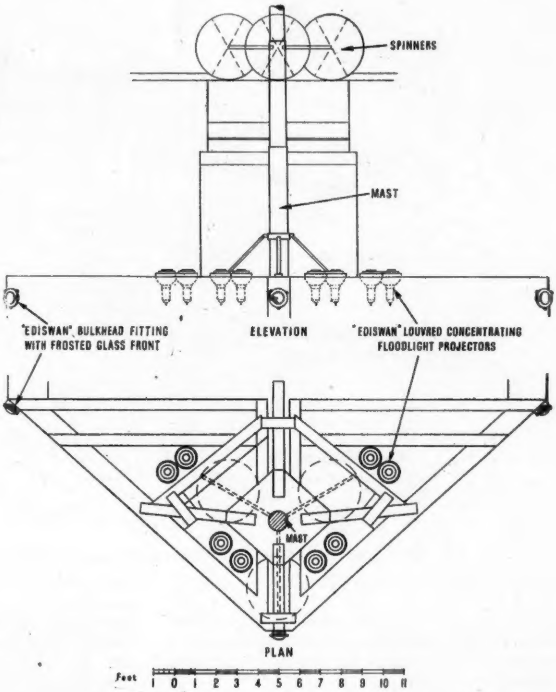
The system adopted for the main footway is the use of 80-watt 5-ft. fluorescent lamps in trough reflectors bracketed off the transoms of the bridge (see Fig. 22.). These lamps are mounted in groups to avoid monotonous repetition. The regular appearance will be further relieved by mounting successive groups of fittings on alternate sides of the transoms as shown in Fig. 21. The service walkway is lighted by means of 150-watt tungsten lamps in vitreous enamelled two-way directional reflectors bracketed off the steelwork of the bridge.

The spinners and the masts are lighted by means of concentrating floodlights mounted in the wooden structure of the piers (Fig. 23). These floods are louvred to prevent glare to persons on the bridge. The star on each mast is lighted by means of six 100-watt tungsten lamps in waterproof holders concealed in a sheet metal ball about 7 ft. below the star. As these lamps can only be reached by means of a bos'n's chair and would therefore be difficult to replace, it is arranged that they be underrun. The flags on the upstream side of the bridge are lighted by means of intensive type floodlights mounted on top of the steelwork on the downstream side. Each of the masts will also carry a 100-watt "Silverlight" lamp at its base.

The Underwater Lighting

For many centuries engineers, artists, and architects have co-operated in the use of water as a decorative media adorning parks, squares, small courtyards, and gardens. The South Bank Exhibition, centrepiece of the Festival, is being well provided for in this

Fig. 23. Showing lighting arrangement on the main piers of the Bailey Bridge.



respect, and schemes are in hand to enhance the beauty of these water features at night with underwater illuminations. The Engineering Division of the Ministry of Works is responsible for both the water features and the major underwater illumination schemes.

It is with the illumination of these water features, however, that this survey is concerned and the various items and effects required are described in the following notes.

There are 18 water features, comprising pools, streams, water gardens, and fountains, on the South Bank site. A number of these present no special aesthetic problems for the engineer, and the main features of interest for the illuminating engineer are centred on the following pools, for which the schemes have been designed by M.O.W. Engineers in conjunction with the General Electric Co. and Messrs. Ferranti Ltd. Fig. 24 shows the siting of these features in the Exhibition grounds.

In general, taking the water features collectively, the main theme is dignity rather than ostentation, and to this end all but one of the illuminated pools will be equipped with fixed lighting with the colour suited to the particular feature. The exception is Pool 12, which, by virtue of its design and situation, will present a multi-coloured aquatic spectacle somewhat on the lines of the 1946 Victory Celebration water illuminations in St. James's Park on a miniature scale.

A sketch of Pool 3 is shown in Fig. 25. Fourteen water jets, arranged in a straight line, are to be illuminated from below the surface of the water with underwater floodlights equipped with daylight colour filters. In addition visors are to be fitted to the floodlights (Fig. 26) to prevent spill light being reflected from the rear wall of the pool. It is the architect's desire to have the fountains portrayed at night as pillars of light standing on a black ground. To this end the rear wall has been faced with Staffordshire blue bricks, which present a black, matt surface at night, and the bottom

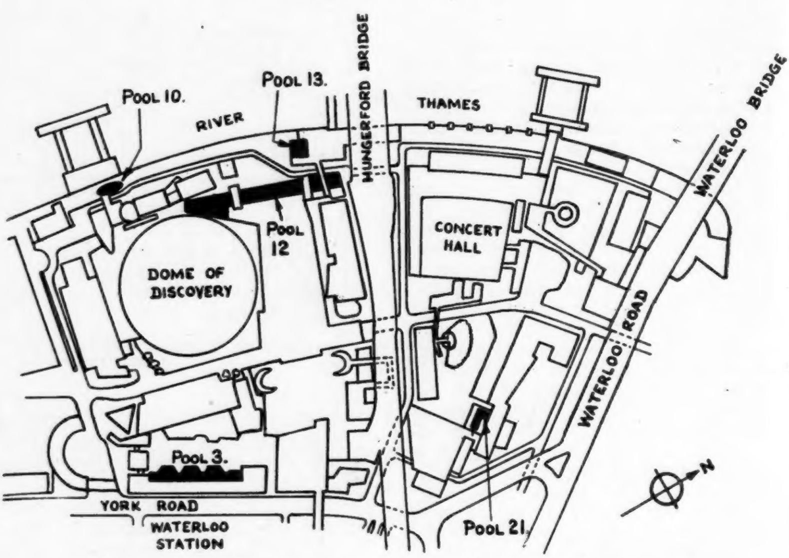


Fig. 24. Showing location of the underwater features in the Exhibition.

surface of the pool is covered with a black, waterproof material. The feature, as a whole, is to present a picture of austere dignity.

As previously stated, Pool 12 is the only water display in the Festival grounds where colour changing will be utilised. The proposal is to adopt three basic colours, white, amber, and flame, with perhaps small patches of more vivid colours to provide contrast. The colour-changing sequence (see Fig. 27) will be similar to that used in St. James's Park during the 1946 Victory Celebrations.

Fig. 28 shows the general layout, and from this it will be seen that the main part of the pool can be divided into six almost identical sections. At the rear of each section two headers will each project three water jets to a height of 30 feet, these being arranged so that the upward flow is slightly forward from the vertical. To the front of these jets, and arranged in arc-formation, is a line of 10-ft.-high jets, so designed as to give the appearance of a continuous wall of water. From the rear wall an almost horizontal jet is to be projected between the two groups of 30-ft. jets, adjusted so that its spray will fall in a 10-ft.-diameter spray ring. The jets from this spray ring will be arranged to play outwards to a height of approximately four feet. To complete the circuit the water will return to the suction pits by way of an arc-shaped waterfall, forming the front edge of the pool. Each of these water effects is the subject of three-colour illumination. A typical underwater fitting is shown in Fig. 29.

The basis of the three-colour change is three circuits operated by a Ferranti moving coil voltage regulator. The fittings on each circuit are equipped with colour screens of one of the basic colours, with some small exceptions, i.e., on Circuit A the floodlights may be generally white, on Circuit B, amber, and Circuit C, flame. Each of these circuits in turn is subject to a variable voltage giving the changing colour effect.

Taking one group of 30-ft. fountains as an example three 150-watt underwater floods are to be grouped round the jet header, each flood to be connected to a separate circuit and each fitted with a different colour filter—say, white, amber, and flame. The complete cycle of operations will show these jets first appearing bathed in silvery white light, and then, after a pause, gradually changing to amber and then to flame, returning after this to white, this cycle being continuous.

By way of contrast a variation on this theme can be employed on the horizontal

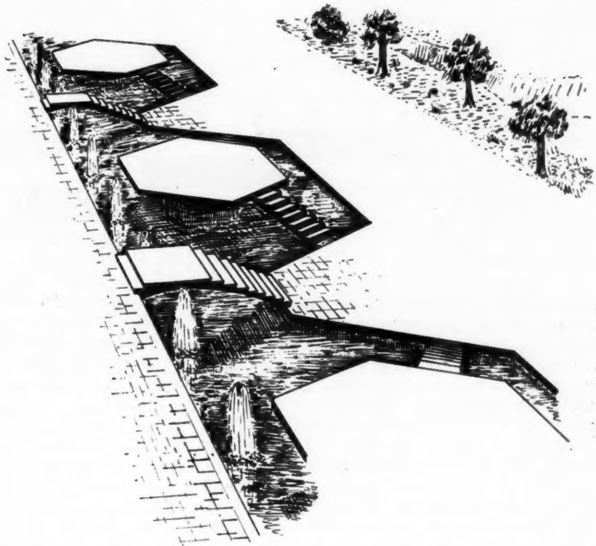


Fig. 25. Sketch of Pool 3.

jets at the point where the spray from these jets falls into the centre of the spray rings. By introducing two different colour screens on the same circuit the colour of the horizontal jet can be made to change from, say, white to amber, whilst the outer sprays change from white to flame. Many variations of this scheme are possible and may be adapted as required. The stepped weir at the front edge of the pool will be subjected to a similar type of colour treatment by weatherproof floodlights concealed under a parapet and directed down on to the water.

In the two end sections of the pool a three-colour underwater lighting scheme similar to that used in the centre section is to be applied to the illumination of a 20-ft. diameter fountain and a 15-ft. high revolving spray.

Pool 13 is to be a small and somewhat secluded water-garden situated in the confines of the Bailey Bridge Restaurant. An interesting feature will be the arrangement

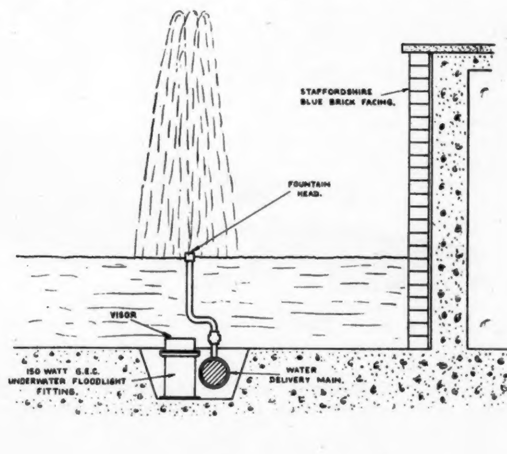


Fig. 26. Section through Pool 3.

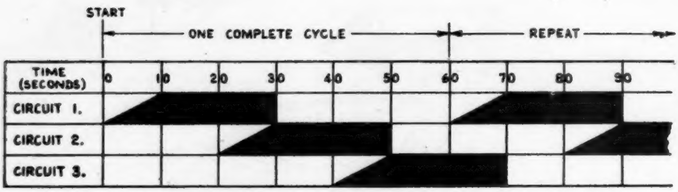


Fig. 27. Diagram showing the colour change sequence at Pool 12.

of small jets incorporated in the design of the coping wall as shown in Fig. 30. The water overflowing the trough and re-entering the pool will form a thin film of water, giving a very picturesque effect, particularly when illuminated. Illumination will be provided by 70 60-watt underwater fittings arranged as shown in Fig. 30. Colour filters will not be necessary as the effect required is of a water-garden, surrounded by a white shimmering border. Concealed lights in the garden will heighten the effect.

Situated in the Homes and Gardens Section is Pool 21, a sculptured figure by Jacob Epstein being the central feature. The floodlighting of the statue will be by five 150-watt G.E.C. underwater fittings positioned in the pool surrounding it. Other underwater fittings of a slightly different design to be inset around the edge of the pool (see Figure 31) will provide an illuminated water-frame, adding dignity to an already formal setting.

All the under-water floodlighting installations will be controlled by switchgear mounted either on or adjacent to the feature. Wiring generally is V.I.R. cables run in conduit from the main switchgear to the fuse-boards, with all final under-water lighting circuits in T.R.S. cable. A system of looped connections in the under-water fittings is being adopted to obviate the cost and trouble caused by under-water jointing.

In the smaller pools the floodlights are few in number and cables between fittings will be run in conduit. This arrangement is not possible in Pool 12, where 660 fittings will be installed, and in this case cables between fittings will be bunched together and clipped to the steel frames locating the floodlights. The number of 150-watt underwater fittings per circuit will vary from 4 to 16, the difference being due to the irregular concentrations of load and the necessity to keep the switchgear pits, and hence the switchgear, as small as possible.

Finally, to prevent water entering the conduits, all outlet boxes situated under water will be filled with sealing compound after the cables have been installed.

Over 600 floodlights of a new submersible type (see Fig. 29) designed by the General Electric Co., Ltd., will be used for illuminating fountains. This new underwater floodlight, measuring only 12 inches high by 8 inches diameter, is made on the diving-bell principle. It consists of an external cylinder, closed at the top by a sheet of $\frac{3}{8}$-inch armour plate glass, inside which is fitted a second cylinder, closed at

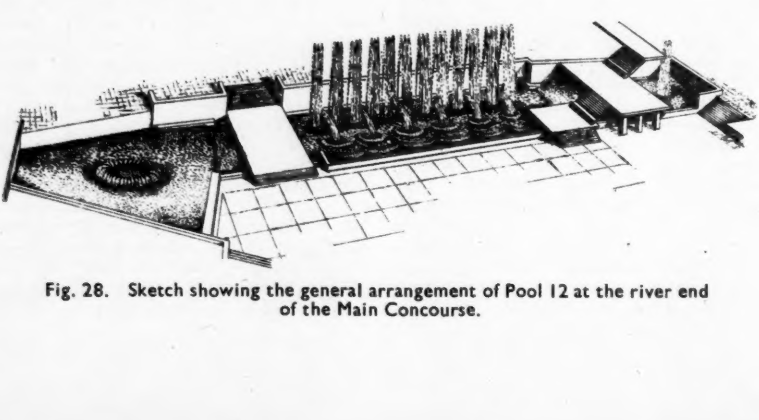


Fig. 28. Sketch showing the general arrangement of Pool 12 at the river end of the Main Concourse.

the bottom. This inner cylinder forms the lamp chamber, and water is prevented from entering it by the pressure of the air trapped under the top cover when the unit is placed under water. The metal box housing the connector is sealed to prevent air from the inside of the unit escaping along the cable. A 150-watt spotlight reflector lamp with internally silvered bulb is used in the floodlight and is held at such an angle that the beam is approximately 15 deg. from the vertical. Lamp replacement is easy as there is no watertight joint to break and reseal when access to the lamp chamber is necessary. The floodlights are sufficiently compact for a number of them to be spaced round the jets of a fountain. Varied colour effects are obtained by adding colour filters

condition for 20 seconds. During the first 10 seconds of this interval the regulator (now unloaded) will run back to minimum voltage and then runs up the voltage on colour two to 240 volts in 10 seconds.

(c) When colour two has attained full brilliance, transfers colour two from regulator to mains and switches off colour one.

(d) Sequences (b) and (c) are then repeated for colours two and three, and the cycle repeated continuously for a periodicity of 60 seconds.

The variation in voltage given by the Ferranti moving-coil regulator is absolutely smooth throughout the complete range. In construction the regulator is similar to a

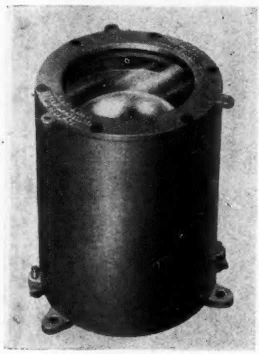


Fig. 29. G.E.C. underwater lighting fitting.

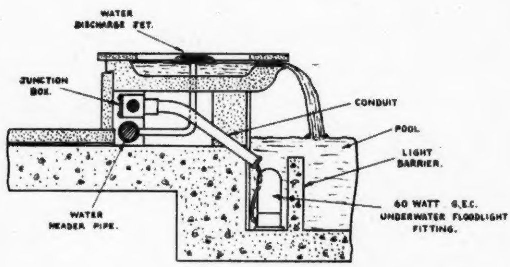


Fig. 30. Section through part of Pool 13 near the Bailey Bridge Restaurant.

and connecting groups of units to individual motor-driven dimmers.

The Ferranti apparatus supplied for controlling the colour changing sequences is constructed to control automatically the supply in sequence of three separate colour circuits, each colour in turn being increased from a low value to maximum brilliance by smooth variation of the voltage applied across the lamps by means of a Ferranti moving-coil regulator. The sequence of the colour changes is controlled by contactors operating in conjunction with the moving-coil regulator.

The sequences are made up to three colours and proceed as follows:—

(a) Runs up colour one from 90 to 240 volts in 10 seconds.

(b) Transfers the load from the regulator on to the mains and maintains this

transformer, the voltage variation being obtained by varying the position of a short-circuited moving-coil in regulation to the fixed coils on the leg of a laminated iron core. There are no electrical connections to the moving parts on the moving-coil regulator, so that slip rings or flexible connections are not required and maintenance is reduced to a minimum.

General Floodlighting External to South Bank Exhibition

The Festival of Britain authorities in co-operation with the Ministry of Works have produced the following schedule of buildings, etc., which are to be floodlit as part of the Festival of Britain decorative scheme. These are to be divided into two parts—Schedule A, buildings to be floodlit every

night during the period of the Festival, and Schedule B, buildings to be floodlit on Wednesdays and Saturdays only during this period.

The "centre piece" as it were of the illuminations outside the Festival Grounds will be that stretch of the Embankment reaching from Westminster Bridge to Blackfriars Bridge, practically the whole of which can be seen from the South Bank. The buildings involved (Schedule A) include the Houses of Parliament, Westminster Bridge, Scotland Yard, Whitehall Court, the Adelphi Building, Shell Mex House, Savoy Hotel, Duchy of Lancaster, Somerset House, Electra House, Inner and Middle Temple, Hamilton House, Carmelite House, City of London School and Unilever House. In addition, out it the scene would not be complete, namely St. Paul's Cathedral.

The buildings in Schedule B are scattered around London and include: St. John's Church, Lambeth (The Festival of Britain Church); Royal Naval College, Greenwich; St. James's Palace; Tower of London; Tower Bridge; Albert Memorial; Lambeth Palace; Albert Bridge; Tate Gallery; Church of St. Mary-le-Strand; St. Brides Church.

These each possess their distinct attraction and it is unfortunate that other considerations prevent their inclusion in Schedule A.

Many of the buildings mentioned above were included in the Victory Celebrations of 1946. Since then, much experimental work has been undertaken by M.O.W. with

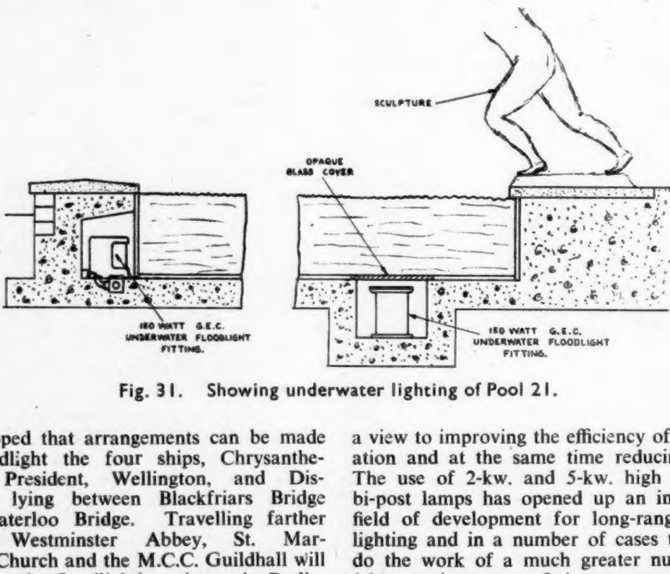


Fig. 31. Showing underwater lighting of Pool 21.

it is hoped that arrangements can be made to floodlight the four ships, Chrysanthemum, President, Wellington, and Discovery, lying between Blackfriars Bridge and Waterloo Bridge. Travelling farther afield, Westminster Abbey, St. Margaret's Church and the M.C.C. Guildhall will complete the floodlighting picture in Parliament Square, while a view up Whitehall will discern the floodlit turrets of the War Office with beyond, the silvery vista of the Trafalgar Square fountains, surmounted by Nelson on his column, and surrounded by Canada House, the National Gallery, St. Martin-in-the-Fields and South Africa House. The Admiralty Arch completes the story in Trafalgar Square. Private owners have been asked to co-operate in this scene of decoration and illumination.

One other building is officially scheduled to be floodlit in this section, and indeed with- a view to improving the efficiency of illumination and at the same time reducing costs. The use of 2-kw. and 5-kw. high intensity bi-post lamps has opened up an interesting field of development for long-range floodlighting and in a number of cases they will do the work of a much greater number of 1-kw. projector-type fittings more efficiently and at less cost. This, of course, applies particularly to buildings where fittings cannot be mounted close to the parts to be illuminated, e.g., top of St. Stephen's Tower (Houses of Parliament) and the Cross above St. Paul's Cathedral. Another function of these fittings is the illumination of large ground areas, the Horse Guards Parade, being a typical instance. Previous schemes here have employed several 1-kw. floods placed approximately 30 ft. from the buildings. These are being replaced by a few 5-kw. floods mounted on the roofs of the

Admiralty and the Foreign Office. It is expected that this arrangement will result in both the building and a part of the parade ground being fully illuminated. This type of fitting will be used in illuminating the upper parts of Whitehall Court during the period of the Festival.

Turning to the more general type of 1-kw., 500-watt and smaller floodlights it is of interest to note that approximately 2,500 of these fittings will be used in the illumination of public buildings, bridges, etc.

Where possible greater use than hitherto is being made of the discharge type of colour lamp, and schemes incorporating numbers of these fittings will no doubt be seen.

The public lighting arrangements and the Festival under-water lighting schemes are being carried out by M.O.W. Engineering staff under the direction of Mr. J. Wilson, Superintending Engineer.

Thanks are due to Messrs. The General Electric Co. and Messrs. Ferranti, Ltd., for permission to incorporate details of their under-water fittings and colour changing equipment respectively.

Acknowledgements

Acknowledgment is made for the help and assistance received in compiling this account from the G.E.C. Ltd., B.T.H. Co., Ltd., and to Siemens Electric Lamps and Supplies Ltd., who were responsible for the sections mentioned in the text. Thanks are also due to the Edison Swan Electric Co., Ltd., who were responsible for the exterior lighting of the Dome of Discovery and the Sea and Ships building, and the lighting of the Main Concourse and the Bailey Bridge, for which they supplied the information and illustrations used in the article.

Thanks are also due to the Ministry of Works, who supplied the details and illustrations of the under-water lighting installations, and the information on the other floodlighting in London which is to be carried out in connection with the Festival.

Correspondence

Brightness Engineering

To the Editor of LIGHT AND LIGHTING.

Sir,—In the March issue of LIGHT AND LIGHTING "Lumeritas," in "Postscript," referred to the one-to-one ratio of the "Q.Q." Committee for idealised visual conditions. I would like to point out that I quoted these recommendations as a matter of interest but did not necessarily associate myself with them. At the same time I cannot help feeling that "Lumeritas's" wholehearted condemnation of this particular recommendation appears to spring from emotional rather than logical considerations. I have always been at great pains to emphasise that brightness ratios related to visual comfort alone and not to the very many other factors which must be taken into consideration in any lighting scheme. In this limited sense it is, in fact, true that a uniformly bright field must represent the acme of visual comfort and the statement cannot be called nonsense. The misinterpretation is by "Lumeritas," who wrongly supposes that a specification for comfortable vision is the same thing as a specification for a well lighted interior.

I have raised this point again because I feel that most of the controversy concerning Brightness Engineering arises from the erroneous supposition that brightness ratio recommendations based purely on visual comfort are intended to be applied regardless of other conflicting aspects of lighting.

It seems to me that the most important thing about brightness engineering is a clear understanding of its present terms of reference.—Yours, etc.,

London. W. ROBINSON.

Educational Films

A new film in the British Electrical Development Association's educational list is "Electricity and Light." The material is fairly easy to take in, the film being intended primarily for showing to school children; it is also of general interest and could be usefully shown to adult audiences. It deals with the filament lamp, the electric arc and the discharge tube in that order and is technical rather than historical.

Produced by Merton Park Studios, Ltd., the E.D.A. Educational Films are of a very high standard and the photography is particularly good. A film on the history of the electric lamp is now in preparation and will be awaited with interest.

Films in this series may be borrowed free of charge from the British Electrical Development Association, 2, Savoy-hill, W.C.2.

Recent Trends in the Design of Schools

Continuing the present series on lighting schools, the authors of this article, who are with the Ministry of Education, describe how the design of primary and secondary schools affects lighting requirements.

By S. A. JOHNSON-MARSHALL,
B.Arch., A.R.I.B.A.,

and E. F. SAMUEL,
M.A.(Cantab.), A.R.I.B.A.

Since the war the design of schools has undergone a very considerable change and further changes are likely. Of the many contributory factors probably three are the most important. First, Educational Authorities have wished to replace the institutional character usually associated with older schools by a more domestic and friendly environment. Secondly, cost limits have encouraged the architect to devote as much area as possible to teaching, at the expense of spaces used solely for circulation. In the average school designed in 1947, over 28 per cent. of enclosed space was devoted to circulation. By 1950 this figure was about 20 per cent. This reduction was not achieved by narrowing the corridors but by a fundamentally different approach to planning. Thirdly, the size of the annual programme is such that it has attracted much study and has provided designers with opportunities to incorporate new ideas in successive buildings. The period has had much the same effect on the development of school design as a war has on the development of aircraft.

Outside the world of educational administration it is frequently not recognised how large is the school building programme and how limited the time within which it must be completed if room is to be found for the rapidly increasing school population. There are about 900 schools under construction; annual programmes of at least the present order will have to be maintained for several years and the present rate of completion will have to be increased if many children are not to be excluded from school.

Almost all the new buildings are primary and secondary schools. Between 1947 and 1950 the relative proportion of primary to secondary was roughly 2 to 1 but this ratio is now changing and eventually the proportions are likely to be reversed.

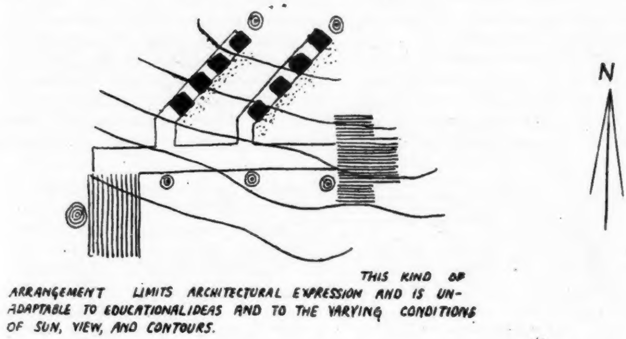
Whilst school design generally is assuming a more domestic and informal character with a consequent reduction in scale, this trend is very much more marked in primary than in secondary schools. Because of this, and also because their use varies considerably, the types are better discussed separately.

Primary Schools

Whilst the greatest area of teaching accommodation is made up of classrooms, it is worth noting the proportion of a school which is allocated to other use. Approximate percentages for schools designed during 1950 are: Class space 30 per cent., hall 13 per cent., meals 5 per cent., entrances 5 per cent., cloakrooms and lavatories 12 per cent., administration 8 per cent., kitchen 6 per cent. and circulation 19 per cent.

Primary schools generally are used less after 4 p.m. than are secondary schools and consequently the lighting installation should be as simple as possible. Specialist teaching rooms are seldom found in primary schools and so the classroom is more inclined to become an all-purpose space. It follows that lighting should also be all-purpose. For example, whereas shadowless lighting may be excellent for two-dimensional work such as reading and writing, it is a disadvantage for model making and all three-dimensional work. Building Bulletin No. 1(1) indicates some of the commoner ways in which classrooms are used.

Children spend more time in classrooms



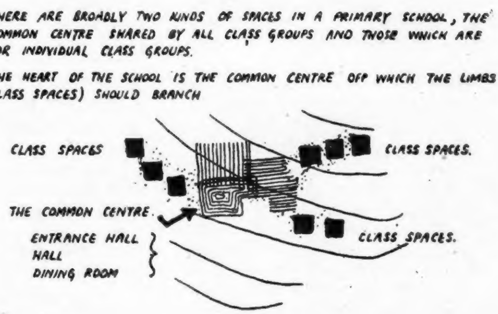


Fig. 1.

than in any other teaching areas, and it is, therefore, reasonable to examine this type of room first. Formerly they were rectangular or square in shape and between 480 and 600 sq. ft. in area. Ceilings were about 12 ft. high, and the main window, along one wall, usually faced S.E., with clerestory windows in the opposite wall over the corridor. Seven or more identical rooms were often strung out along a lengthy corridor with large concentrations of cloakrooms and lavatories located centrally (Figs. 1 and 2). In the classrooms, children sat in rows facing the teacher and the blackboard, with the main window on their left. A static arrangement of this kind produces a comparatively simple lighting problem, but as teaching methods are

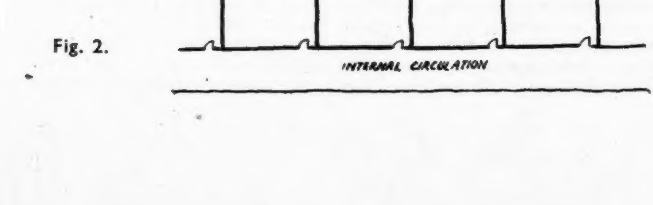


Fig. 2.

changing in ways which make life more difficult for the lighting specialist, it is worth examining some of the methods.

Much teaching is now done informally and children spend a large part of their time working in groups of five or six and sometimes in even larger numbers. They will, of course, face in any direction. Their premium. There can never be too much usable wall area and, ideally, this should be chalk-board and pin-up surface in one. As it is used mainly by the children the top edge should not be more than 5 ft. and the bottom edge not less than 2 ft. from the floor. It does not replace the chalk-board used by the teacher, and so special lighting

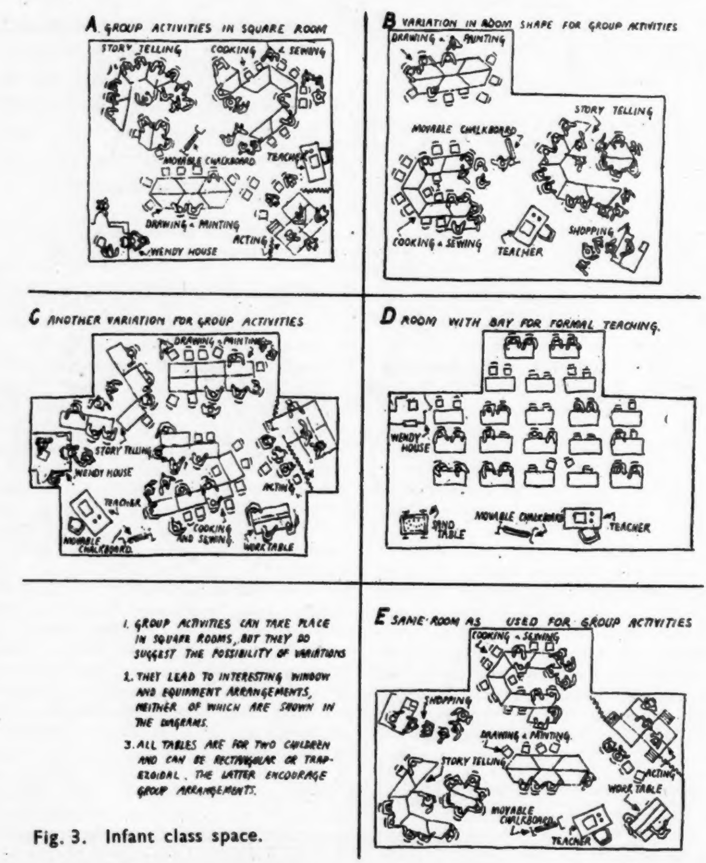


Fig. 3. Infant class space.

activities may include "shopping," dressing-up, painting and modelling, and the exact areas in which these take place cannot be predetermined. There are also many occasions when children will be taught formally and when chairs and tables will be arranged accordingly, but much time will inevitably be devoted to a wide range of practical work when wall- as well as floor-space is at a is unnecessary, but Dr. Hopkinson's remarks about colour in a previous article have an important bearing on its treatment.

If wall surfaces at child height are to be used as ancillary chalk-boards the reflection factor should be nearly as low as that recommended by Dr. Hopkinson for normal chalk-boards, i.e., 15 per cent. He also recommends reflection factors below 60 per

cent. for walls generally. Fifteen per cent. over all wall surfaces would produce a gloomy effect, but if judiciously used on lower areas with higher reflection factors elsewhere, both physiological and functional requirements should be met. (This does not mean a return to the use of dados.)

The lighting requirements of the teacher's chalk-board have been discussed in previous articles. When the board is fixed to a wall the extra light needed can easily be provided by neat and unobtrusive fittings on the ceiling. But there is an increasing demand, especially in infants' schools, for mobile chalk-boards. Whilst it is difficult to provide this type of board with special lighting, the disadvantage is offset by a natural tendency to wheel the board close to the group under instruction. If preferential chalk-board lighting is provided in the usual position, the mobile board can be moved to it when the whole class is being taught formally.

Although the floor areas have not altered much, the emphasis on freer teaching methods has produced some interesting classroom designs. For instance, some have projecting bays which are large enough for several children to work in, while others are shaped like a shallow T, and in many cases the store is designed as an alcove opening out of the room. Fig. 3 indicates several types. They are usually planned in groups of two, three, or four, each with its self-contained cloakroom and lavatories. The groups are conveniently disposed round the assembly hall—dining hall—entrance hall unit which becomes the focus of the school (see Fig. 1). By departing from the concept of straight blocks of classrooms linked by corridors, and replacing it by freer planning, it is often possible to provide sill-height and clerestory windows in more than one wall. The function of the window can then be reconsidered. In the past the main classroom window performed three essential functions. It was the main source of light and sunshine, it was a ventilator, and it framed a view. This often led to complicated assemblies of opening units which in turn produced visually thick metal members. Seen against the background of sky these members usually became irritating sources of glare. Freer planning allows the designer to separate the functions of windows and to redistribute them on a more rational and aesthetically satisfactory basis.

For instance, if adequate light and cross-ventilation can be provided by high level windows on three walls, or perhaps on one wall by a simple toplight, then the main window need only range from sill height to door head level. No horizontal bars need obstruct the view and the number of vertical members, conditioned by the safe limits of sheet glass, will be few. If opening units alternate with fixed ones, the vertical members will remain slender. Furthermore, if the wall area above this window is reasonably lit a second important source of glare will have disappeared. In addition it will have been possible to reduce the total window area of the room.

A departure from the old corridor classroom relationship also permits other changes. Where it is no longer essential to locate sources of cross-ventilation and secondary lighting over the corridor, the height of classroom ceilings can be lowered. Most designers feel that an 8 ft. to 9 ft. height is more appropriate to small children than is 12 ft. The reduction in height should also help to reduce building costs. Where the plan form does not permit convenient side lighting, a small ventilating top light will usually suffice. If the unit is kept small it is easily made, inexpensive and glare-free.

It might be argued that side lighting could be abolished in favour of toplight, that this approach would permit buildings of infinite "depth" and with the minimum of external walling, and that this is the way to achieve really substantial economy. Two powerful objections are immediately apparent. First, that lighting solely by low level glare-free top-lights, produces a soporific effect which is more appropriate to an afternoon nap than lively work, and secondly, unless the room is very large (say 80 ft. x 80 ft.), a sustained inability to "see outside" induces a feeling of claustrophobia in most human beings.

Whilst lower classroom ceilings simplify the problem of designing against daylight glare, they make the design of good artificial lighting more difficult than it has been in the past. Before discussing solutions it is worth reviewing the main requirements. The quality of lighting, described in Dr. Hopkinson's and discussed in Mr. Weston's articles, should be provided over the whole area of the classroom where the working plane is only 1 ft. to 2 ft. from the floor. It should be equally suitable for two- or three-dimensional vision and it should have sufficient sparkle to stimulate without causing distraction. As classrooms are used mainly during the day, fittings should be as unobtrusive as possible.

Dr. Hopkinson says that if the areas used for group activities can be predetermined, preference should be given to lighting by a

few appropriately suspended large fittings. But to prescribe the size and locality of groups would offend against the tenets of an educational system which sets out to give the teacher the maximum opportunity to develop new or different ways of teaching.

Perhaps the ideal type of installation that could now be devised would consist of a series of well-distributed small fittings to provide moderately bright background lighting with the addition of five or six large units each mounted on a telescopic horizontal yardarm which would allow it to pivot about a point on the ceiling and be poised anywhere within a 3 ft. radius—in fact, a hanging standard lamp. Almost inevitably this type of fitting would be complicated and expensive and would probably dominate the room in daylight.

The practical answer seems to be Dr. Hopkinson's alternative method of lighting by a large number of small units. Successful installations of this kind are already in use but the problem provides scope for more development.

In the first article of this series the author, a schoolmaster, asked for far better lighting in corridors, cloakrooms, and lavatories. Most post-war schools are fairly good in this respect, but new planning developments add point to his plea. When classrooms are grouped in small numbers the corridor is seldom used during lesson time. In an endeavour to satisfy the perpetual demand

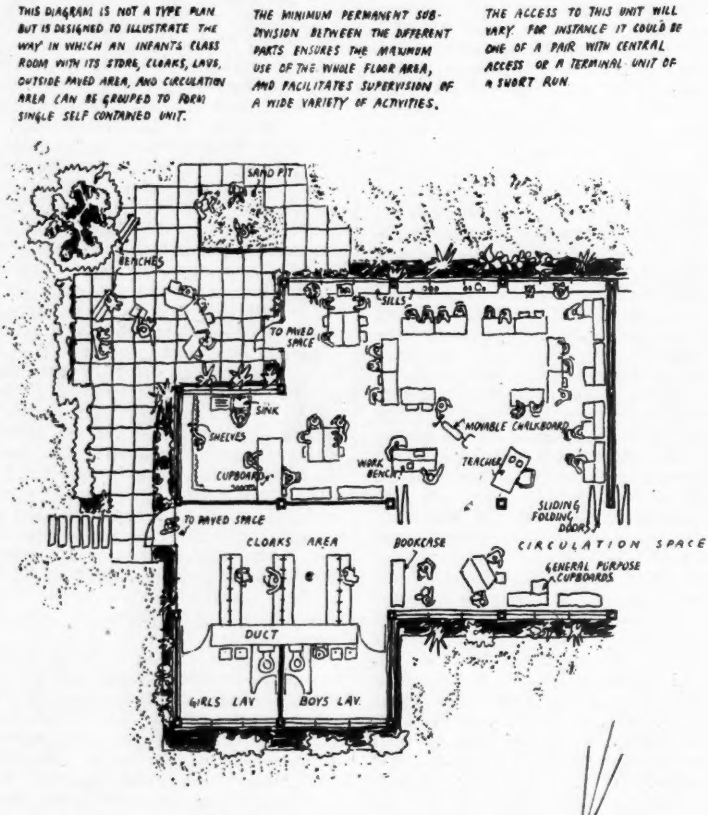


Fig. 4. Infant class space.

for more space there is a tendency to design the corridor in such a way that it can be used as an extension of the classroom for the purposes of practical work (Fig. 4).

Secondary Schools

During the period 1945 to the middle of 1950 about 230 secondary schools were either under construction or completed. Of these approximately 212 were secondary modern, seven were secondary grammar, seven were secondary technical, and three or four were comprehensives.

Whilst many of the recent developments in primary school design apply also to secondary schools, they do so in varying degrees according to the type of school. Freer planning is common to all, and ceiling heights, too, will often be lower than in the past, but except in the smaller rooms, they are unlikely to be less than 9 ft. As most secondary schools will be used during the evenings, a good lighting installation is essential.

In grammar schools, classrooms are used mostly for formal instruction and as pupils will spend much of their time facing a static chalkboard the rooms will be directional in character. As the specialist teaching rooms are also equipped and arranged on a more formal pattern, lighting problems in this type of building are rather simpler than those encountered in primary schools.

Requirements of secondary modern schools are different because recent developments in their design are somewhat similar to those of primary schools. Classrooms will be used for informal as well as academic study (see Fig. 5). In some, informal work will include light practical tasks such as model making and needlework, others which are planned in close association with specialist rooms, will inevitably take the overflow of practical work from their adjacent room(2). Many of the specialist rooms have less static equipment than those of grammar or technical schools. For instance, in science laboratories, sinks and service points will often be located along the walls, leaving the main floor area free for the arrangement of movable work benches to suit a variety of tasks. In fact all-purpose lighting is called for in most rooms in this type of school.

The secondary technical school is a new type and all concerned in its development should be prepared to experiment. It has a high proportion of practical accommodation

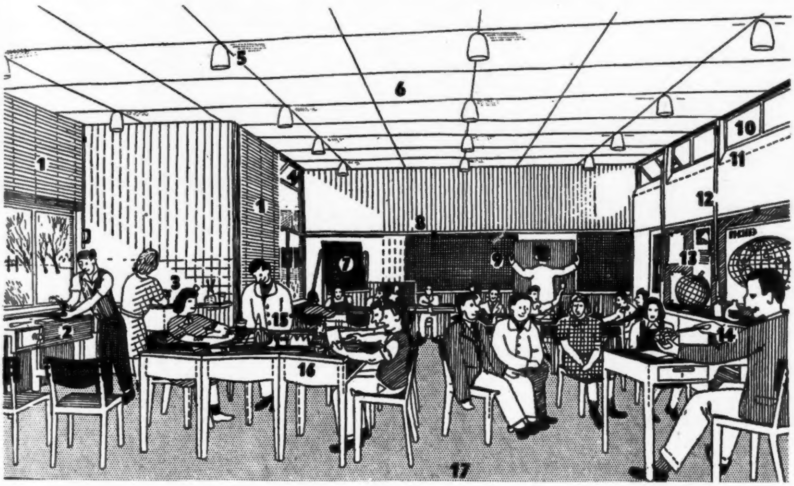


Fig. 5.

1. Louvred blinds. 2. Work bench. 3. Sink. 4. Ventilators at high level. 5. Simple low-brightness light fittings. 6. Sound absorbing and light-reflecting ceiling panels. 7. Mobile chalkboard. 8. Channel at head and sill locating the chalkboards. 9. Removable and reversible chalkboards. 10. Clerestory ventilators. 11. Sloping sill to give additional daylight. 12. Ventilator control gear. 13. Pin-up and chalkboard area. 14. Store cupboards. 15. Wide window-sill. 16. Dual tables arranged for group and practical work. 17. Quiet floor surface.

in which lighting will have a static function, while in classrooms, conditions are likely to be similar to those in secondary modern schools.

* *

Analysis has shown that when the total price of schools is about 57s. per sq. ft., the price of the lighting installation averages about 2s. 2d. per sq. ft. With the increasing demands for economy it is essential to examine every means of reducing costs without lowering standards of performance. In a previous article it was suggested that much could be done to simplify and improve the design of lighting fittings. Such work is unlikely to satisfy present needs unless it also produces a reduction in price. However, it would be wrong to concentrate on fittings without considering every other element in the installation. For instance, some of the new systems of building construction are designed for dry assembly and it is, therefore, relatively easy to gain access to the services if they are kept above ground. In cases like this is it really essential to run all wiring in conduit? If not, it would be possible to save about £500 on an average-sized primary school. Such a sum would more than cover the increased number of points that seem to be needed if the quality of lighting is to be improved.

In all schools the quantity of light is obviously important and in the future, when knowledge and economic circumstances justify it, higher levels of illumination may be specified, but there is little to be gained by increasing quantity without raising quality. In the meantime much can be done to improve quality at the present levels of illumination. The task is not easy during a period of increasing economic stringency, but if full advantage is taken of recent research, and if there is the closest collaboration between lighting specialist and architect, there is every hope of success.

References

(1) Ministry of Education Building Bulletin No 1, H.M.S.O., 1949.

(2) Ministry of Education Building Bulletin No. 2, H.M.S.O., 1950.

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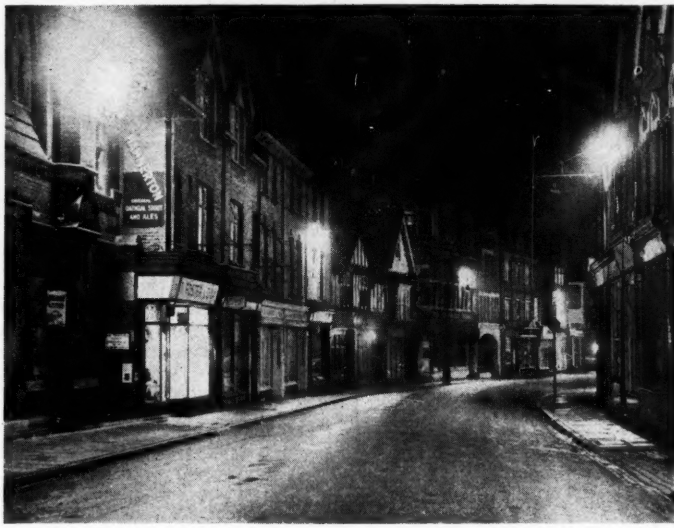
Fluorescent Street Lighting

Describing a trial installation of fluorescent lamps fixed on to the face of the buildings.

The siting of lamp columns to fit in with his lighting scheme and yet to cause as little obstruction as possible has always been one of the problems of the street lighting engineer. The problem has not changed much with the passing of years but has, if anything, become more acute owing to the improved lighting of streets and the need to use larger lighting units. In some cases wall brackets or span wires between buildings have been used, but in the great majority of street lighting installations there appears to be no alternative to lamp columns. There are modern columns now available which take up less space on the pavements, but they are still obstructions as far as pedestrians are concerned and the siting of them is still often influenced by the maze of services to be found beneath the pavements in any town. There has also been considerable criticism lately of the size of fluorescent street lanterns now in use. Sited as they usually are it is inevitable that their bulk should be most noticeable.

With such matters in mind the lighting engineer of the East Sussex and South-West Kent Sub-Area of the South-Eastern Electricity Board conceived the idea of using fluorescent lamps in suitable lanterns fixed direct to the faces of the buildings, and with the encouragement of Mr. N. Boydell, manager of the Sub-Area, a series of experiments were carried out to test the practicability of the idea.

The results of the tests were promising, and with the collaboration of the Eastbourne Corporation a trial installation has now been brought into operation in South-street, Eastbourne. The installation consists of nine lanterns along a 460-ft. stretch of this road, the carriageway of which averages 30 ft. in width, with footpaths of an average of 7 ft.



The trial installation at South Street, Eastbourne.

in width. The lanterns have been connected with temporary wiring run from the existing street lanterns. Permanent wiring would need only one underground service on each side of the street with the lanterns interconnected by surface wiring.

The lanterns being fixed to the fronts of the buildings are hardly noticeable by day, whilst, with the removal of the existing lamp columns, the footpaths would be unobstructed. The criticism of unsightliness during the day time, which is so frequently levelled at fluorescent street lighting installations does not apply in this case.

At night time the effect is of the street being lighted by a very soft light which is free of glare. The absence of glare is most noticeable particularly at the ends of the street where other normal installations can be seen and comparison can easily be made. This type of installation also appears to have advantages on wet nights when normally the brightness contrast of the road surface is increased by the formation of very bright and very dark streaks. This does not happen with the wall-mounted fittings to anything like the same extent. Each lantern houses only one 5-ft. lamp, and the average lumen output is approximately 4,500 per 100 ft. of road.

It is expected that capital and annual maintenance costs will compare favourably with those of more orthodox installations. The use of this kind of mounting is, of course, limited to certain types of streets, but there must, nevertheless, be many such streets where the system could be used with advantage.

Open Days at the N.P.L.

The National Physical Laboratory at Teddington is holding Open Days for industrial representatives on Monday and Tuesday, May 28 and 29. These Open Days, held this year in conjunction with the Festival of Britain, are an opportunity for scientific and technical workers in industry to see the scientific research work and special investigations undertaken at the laboratory. The laboratory will be open on each day from 10.30 a.m. to 5.30 p.m., and luncheon and tea may be obtained on the premises. A number of tickets is being reserved for postal applications from accredited representatives of industrial organisations and those interested are invited to apply to the Director, National Physical Laboratory, Teddington, Middlesex, not later than May 8, indicating on which of the two days they would prefer to visit the laboratory.

At the meeting of the Utilisation Section of the I.E.E. to be held in London on May 3, at 5.30, a paper entitled "A New Power Stroboscope for High-Speed Flash Photography" by W. D. Chesterman, D. R. Glegg, G. T. Peck and A. J. Meadowcroft will be read and discussed.

Recent Meetings of the Colour Group

Mr. F. L. Warburton, of the Wool Industries Research Association, recently gave an interesting lecture on the importance of variations in normal colour vision as affecting practical colour matching in industry.

It is, of course, well known that individuals whose colour vision would be classed as "normal" in every case, nevertheless show considerable variations in their relative response to the different parts of the spectrum, and the lecturer said that in a large number of cases these variations were attributed to different degrees of yellow pigmentation at the macula, the central part of the retina containing the area of most distinct vision. It is upon this area that an observer focuses the image of the object he is looking at, and it has been found that, whether or not the explanation has a basis in fact, the variations observed are often of the kind which would result from inserting yellow filters of appropriate densities in the optical train of the eye. Further, it has been found that there is some correlation between the magnitude of the effect and the age of the observer.

Mr. Warburton said that Dr. Wright had studied the effect quantitatively, and his results showed that the chromaticity of a white light varied, for normal observers, over a range as great as that between colour temperatures of 3,500 deg. and 7,500 deg. K. Therefore it might well be expected that the colour-rendering properties of a white light would vary as much for different observers as would that of black-body sources varying over the range mentioned for a single normal observer. This surprising conclusion had been confirmed, the lecturer said, in a survey of 250 persons connected with the wool textile industry and related trades. The survey was carried out during the course of an exhibition of artificial daylight fittings held at Leeds, and was reported in *Light and Lighting* for August.* The test consisted in matching a standard dyed pattern with one of a series of dichroic patterns dyed from a different recipe so that, although the observer was able, in nearly every case, to obtain a sensation match, the spectral distribution was markedly different. Thus observers weighting different parts of the spectrum differently obtained results which gave an indication of the extent of their "macular pigmentation." Analysis of the results showed a change in the matches such as would result from an increase of pigmentation with advancing age, thus confirming previous results obtained by altogether different methods.

The lecture was followed by a discussion in which several speakers, including the chairman, Dr. W. S. Stiles, suggested that observers might be "corrected" for macular pigmentation by supplying them with glasses of the appropriate transmission, but Mr. Warburton said that in fact a considerable degree of standardisation of observers would be achieved by proper selection, as it had been found that some 60 per cent. of the individuals tested came quite close to the mean. Matters were therefore not as bad as might be concluded from a consideration of the total range given by the whole group tested.

Iron in Glass

A constant requirement in the manufacture of glass is the elimination of the green colour associated with the presence of iron. This problem formed the practical background to the researches recently described by Professor Moore, of the Department of Glass Technology, Sheffield University.

The atoms of iron in combination can exist in two main valency states—the ferrous and the ferric—and it is to be expected that in different glasses the proportions will differ and that there will be corresponding modifications in the spectral absorption curve of the glass. With this notion as a starting point, Professor Moore had prepared series of glasses, containing

* The actual results obtained are shown diagrammatically on pp. 299 and 300.

different amounts of iron, in which the chemical environment was either reducing, to favour the ferrous condition, or oxidising, to favour the ferric condition. The spectral absorption of the reducing glasses could be explained quantitatively in terms of a single type of absorbing material—iron in the ferrous state—so that the absorption curve of a glass containing a given amount of ferrous iron could be predicted. The oxidising glasses gave less simple results, but it was possible to arrive at the form of the absorption curve associated with ferric iron and an approximate estimate of the degree of absorption produced by a given quantity. On studying glasses not of the fully ferrous or fully ferric types, however, Professor Moore found that their spectral absorptions could not be represented as a simple resultant of the ferrous and ferric absorption curves. It was necessary to assume that some of the iron existed in a so-called ferroso-ferric condition—for which there was independent evidence—the absorption of ferroso-ferric iron being "grey," i.e., nearly independent of wavelength in the visible region. Even then the whole of the iron in the glass was not, as a rule, accounted for, and a fourth state of the iron atoms in which they contributed nothing to the observed absorption had to be postulated. Professor Moore stressed that the method of analysis he had applied to glasses containing iron had become feasible with the introduction of apparatus for the rapid automatic recording of spectral transmission curves, and that a wide field of application of the method to all kinds of coloured glasses was now open.

Lighting Economy and Building Construction

The economics of interior lighting, with special reference to building construction, is the subject of a recent book published in Sweden by H. Kreuger. (State Committee for Building Research, Arsenalsgaten 1, Stockholm, Sweden.) The author has studied the window from the economic point of view, and in the book he gives a method of calculating economic window dimensions.

The calculations are based on a definite level of interior lighting, natural or artificial, which is fixed according to accepted recommended values of illumination. During the winter, natural lighting has often to be supplemented by artificial lighting; work begins in the morning under artificial light, which is switched off when the daylight is adequate. During the afternoon the artificial lighting is again switched on when the daylight again falls to approximately that of the minimum recommended value.

For every window dimension and level of interior lighting the time during which daylight alone may be used and the time during which it must be supplemented by artificial light can be calculated by the use of outdoor lighting curves. The larger the windows the shorter becomes the period of artificial lighting, and the cost of artificial lighting is therefore reduced. At the same time, however, the cost of heating would be increased. Though they reduced the cost of artificial lighting, large windows tend to increase the cost of heating; small windows, on the other hand, reduce the cost of heating but increase the cost of artificial lighting. It must also be remembered that large windows are more expensive than small ones and the cost of maintenance is higher. Consideration of these factors will enable one to decide on the most economical window dimensions.

The position of windows should also be considered; badly placed windows will give poor daylighting and hence help to increase the period of artificial lighting, but the heat losses will be the same as if the windows had been placed to the best advantage by good planning.

The author also suggests that the economics of daylighting and artificial lighting are so closely connected that they should always be considered together. For instance, if the level of interior illumination is doubled the cost of artificial lighting will be more than doubled because, owing to the increased level, the artificial lighting will be in use for a longer period.

This new approach to the economics of lighting makes this contribution one of considerable interest. The aim of engineering techniques is to make as much progress as possible at the lowest cost, and this can only be done by economic analysis.

GUNNAR PLEIJEL.

Assessment of Colour Rendering Properties of Fluorescent Lamps

By W. HARRISON,* B.Sc.

Increasing interest is being taken in the measurement and specification of the colour rendering quality of fluorescent lamps. The eight spectral band method of measurement is already established and this article suggests how the data may be utilised to assess the colour quality of a lamp.

Introductory

The practice of determining the spectral distribution of the light from fluorescent lamps by measurement of the luminance in eight agreed wavebands is well established in Great Britain and has proved a satisfactory means of expressing the spectral distribution. It seems likely to remain the most acceptable method, possibly with slight modification to the number or boundaries of the wavebands.

The present paper is concerned with the interpretation and presentation in simplified form of the eight spectral band data with a view to enabling an assessment of the colour rendering properties of a fluorescent or other lamp to be made more readily than from the eight spectral band values alone. It is suggested that the use of ratios of the spectral band values enables this to be done and suggestions for the derivation of such ratios are given.

A method of expressing colour rendering properties recently described by Jerome and Judd(1) is based on colour computations on three so-called "metameric pairs" of materials; from these a single value termed the "Duplication Index" is derived, which is taken as a measure of the faithfulness of the rendering of colours by an illuminant as compared with a standard. The present paper suggests how a comparable single figure can be obtained from the spectral band data, but points out the uncertainty which may arise from the use of a single evaluation of colour rendering properties.

* Siemens Electric Lamps and Supplies, Ltd., Preston.

Subjective Effects in the Rendering of Colours: Simultaneous Colour Contrast

The adaptability of the eye is such that large changes in the colour (chromaticity) of materials due to change of illuminant can pass almost unnoticed. The change from daylight to incandescent tungsten light produces a change in the chromaticity of white materials of the following order:—

	x	y	z
In daylight (6,000 deg. K)	.322	.335	.343
In incandescent tungsten light.	.452	.409	.139

Yet the subjective impression is that white materials look very much the same in daylight and in incandescent light.

The adaptability of the eye to large changes in brightness (luminance) is comparable. Colours usually appear little changed when the illumination level of a room is changed.

There is, however, one requirement which must be met when the illuminant is changed for materials to appear little changed; viz., the contrast between colours seen simultaneously shall not appear abnormal. The eye is very sensitive to changes in colour contrast, and it is a well-known phenomenon that the subjective effect of a colour is considerably influenced by adjacent colours (simultaneous colour contrast).

Colour Contrast Factors from the Spectral Band Data

Since simultaneous colour contrasts are so important it is suggested that contrast factors which can be obtained from ratios of spectral band luminance values should

help in assessing the colour rendering properties of fluorescent lamps.

The spectral bands are:

Band No.	Waveband A.U.	Colour.
1	3800 — 4200	violet
2	4200 — 4400	violet
3	4400 — 4600	blue
4	4600 — 5100	blue-green
5	5100 — 5600	green
6	5600 — 6100	yellow
7	6100 — 6600	light red
8	6600 — 7600	deep red

In selecting the ratios to be used the following procedure has been adopted:—

(1) Bands Nos. 7 and 8 have been taken together as Red.

(2) Bands Nos. 1 and 2 have not been included, for although they have an important effect on the colour rendering properties of the lamp they are largely made up by the violet mercury lines of 4047A and 4358A. Thus the colour rendering effect of these bands is largely the same in all fluorescent lamps, and especially so in lamps of similar colour.

(3) It has been considered preferable that all the ratio shall be in terms of Band No. 6. The yellow is approximately in the middle of the spectrum and has often the largest luminance value.

The ratios selected are:—

$$\frac{\text{Red}}{\text{Yellow}} = \frac{\text{Bands Nos. 7 and 8}}{\text{Band No. 6}}$$

$$\frac{\text{Green}}{\text{Yellow}} = \frac{\text{Band No. 5}}{\text{Band No. 6}}$$

$$\frac{\text{Blue-green}}{\text{Yellow}} = \frac{\text{Band No. 4}}{\text{Band No. 6}}$$

$$\frac{\text{Blue}}{\text{Yellow}} = \frac{\text{Band No. 3}}{\text{Band No. 6}}$$

The Equal Energy spectrum may be considered as an illuminant which gives equal

TABLE 1

Percentage Luminance in Eight Spectral Bands for Illuminants of Near Daylight Colour

Spectral Band No.	Equal Energy	6500 deg. K full radiator	Colour Matching White Fluorescent	4500 deg. K full radiator	Daylight Fluorescent	Natural Fluorescent	Cool Whites (Jerome and Judd)			
							A	B	C	D
1	.031	.032	.021	.018	.015	.015	.012	.013	.012	.014
2	.23	.26	.47	.175	.37	.38	.40	.33	.32	.32
3	.73	.83	.62	.56	.38	.37	.294	.45	.39	.34
4	9.64	10.65	9.0	8.75	5.7	5.4	5.57	6.68	6.32	6.64
5	40.1	41.8	43.6	39.2	39.0	36.1	45.0	42.3	42.3	40.9
6	37.1	35.8	37.1	38.4	46.7	48.0	35.0	39.9	39.4	44.8
7	11.26	9.90	8.9	12.0	7.6	9.47	13.17	9.99	11.01	6.84
8	.86	.68	.28	.89	.22	.25	.625	.325	.30	.125

TABLE 2

Percentage Luminance in Eight Spectral Bands for Illuminants of Warm Colour

Spectral Band No.	Illuminant A	Warm White Fluorescent	Mellow Fluorescent	Warm Whites (Jerome and Judd)			
				E	F	G	H
1	.0056	.011	.009	.007	.008	.006	.006
2	.058	.31	.32	.224	.33	.254	.217
3	.247	.17	.11	.166	.058	.084	.142
4	5.36	2.39	1.91	2.85	2.46	3.70	2.23
5	33.5	29.1	28.5	37.7	42.4	45.9	31.7
6	42.7	56.0	51.7	46.1	39.4	38.6	57.9
7	16.59	11.5	16.9	12.55	14.2	11.20	7.76
8	1.55	.35	.50	.45	.61	.27	.072

TABLE 3
Colour Contrast Factors for the Illuminants of Table 1

Ratio	Equal Energy	6500 deg. K full radiator	Colour Matching White Fluorescent	4500 deg. K full radiator	Daylight Fluorescent	Natural Fluorescent	Cool Whites (Jerome and Judd)			
							A	B	C	D
Red / Yellow	100	90	76	103	51	62	120.5	79	88	47.5
Green / Yellow	100	108	109	94.5	77	70	119	98	99.5	84.5
Blue-green / Yellow	100	114	93	88	47	43	61	64.5	62	57
Blue / Yellow	100	117	84	73.5	41	39	42.5	57	50	38.5

TABLE 4
Colour Contrast Factors for the Illuminants of Table 2

Ratio	Illuminant A	Warm White Fluorescent	Mellow Fluorescent	Warm Whites (Jerome and Judd)			
				E	F	G	H
Red / Yellow	130	65	103	86.5	115	91	41.5
Green / Yellow	72.5	48	51	76	99.5	110	50.5
Blue-green / Yellow	48.5	16	14	24	24	37	15
Blue / Yellow	29	15	11	18	7.5	11	12.5

emphasis to all colours and so the above four ratios for the Equal Energy luminance values have been converted to 100 in each case. The ratios for any other illuminant are correspondingly expressed as percentages of the Equal Energy values to give the four Colour Contrast factors.

It will readily be appreciated that a value greater than 100 for, say, the Red/Yellow factor indicates that the illuminant will emphasise Red more than Yellow as compared with the Equal Energy illuminant.

Colour Contrast Factors for a Number of Illuminants

Tables 1 and 2 give the spectral band data for a number of illuminants including the four Cool White and four Warm White lamps of Jerome and Judd. The data for fluorescent lamps, whilst typical of the various colours is given primarily to illustrate the method of assessment of colour-rendering properties and should not be regarded as necessarily applicable to any particular commercial lamp.

Tables 3 and 4 give the colour contrast factors which have been obtained from this data.

Correlation with "Duplication Indices" of Jerome and Judd

It is felt that generally the Colour Contrast factors should be considered individually since each refers to the rendering of a

different part of the spectrum. A single figure of merit can only give an average value for the faithfulness of the rendering of various colours, and as the figure deviates further from 100 so the specification of the colour-rendering properties by a single figure becomes more uncertain.

Suppose, for example, two illuminants have each a figure of merit of 60, but one is deficient in red while the other is deficient in blue and green. The rendering of reds and greens by the two illuminants will be significantly different.

Therefore, in employing a single figure evaluation for specification purposes, it is very desirable to have a reference standard which has the same chromaticity as the test illuminant and as nearly as possible the same type of spectral distribution. If the chromaticities are different the evaluation of colour rendering quality by a single figure becomes more uncertain; this difficulty arises when fluorescent lamps having colours off the full radiator locus are assessed in terms of full radiators, e.g., the evaluation of warm colour fluorescent lamps in terms of Illuminant A.

However, bearing in mind the above, it was thought worthwhile to attempt a correlation with the Duplication Indices of Jerome and Judd and a single figure of merit for each lamp was obtained in the following way:—

For the Cool White lamps the average deviation of the factors from the corresponding ones for the 4,500 deg. K full radiator was obtained. The figure of merit is the difference between 100 and the average deviation value.

The calculation for the Warm White lamps was similar, except that Illuminant A was the reference standard.

Table 5 shows the correlation of the figures of merit so obtained with Jerome and Judd's Duplication Indices.

Table 6 gives the figures of merit obtained in the same way for the other fluorescent lamps of Tables 3 and 4, the reference standards being 6,500 deg. K full radiator for the Colour Matching White, 4,500 deg. K full radiator for Daylight and Natural, and Illuminant A for Warm White and Mellow

TABLE 5

Lamp		Figure of Merit from Colour Contrast Factors	Duplication Index
Cool White	A	75	69
,,	B	83	75
,,	C	83	76
,,	D	67	58
Warm White	E	79	63
,,	F	78	69
,,	G	73	54
,,	H	60	45

TABLE 6

Lamp	Figure of merit from Colour Contrast Factors
Colour Matching White	83
Daylight	64
Natural	64
Warm White	66
Mellow	75

It will be noted that the same figure is obtained for Daylight and Natural. This indicates that the average faithfulness of the rendering of colours compared with that by the 4,500 deg. K full radiator will be approximately the same for the two colours. However, it is well known that the Natural lamp is generally more pleasing than the Daylight lamp in its rendering of colours, and the above figures illustrate the points made previously that it is better to consider the four Colour Contrast Factors individually or, if a single figure of merit is required, to select a reference standard having the same chromaticity and approximately the same spectral distribution as the test lamp.

Conclusions

Four Colour Contrast Factors as described may enable an appraisal of the colour-rendering properties of a fluorescent lamp to be made more readily than the eight spectral band values above.

For specification purposes there is an obvious attraction in a single figure of merit or Duplication Index. Where there is no chromaticity difference between the test lamp and the reference standard and especially if the spectral distributions are roughly of the same type, a single figure evaluation can probably be used. Lamps of the Colour Matching and Daylight types with corresponding full radiators as standards would fall within this class.

Where there is a chromaticity difference

between the test lamp and the standard, a single figure evaluation is not so satisfactory, hence, full radiators are not very satisfactory as standards for assessing the colour-rendering properties of Natural, Warm White and Mellow lamps.

Since the Colour Contrast Factors have been expressed in terms of spectral band No. 6 it may be necessary to specify a minimum luminance value for the band not far below the value for the standard. A colour specification for a fluorescent lamp might therefore comprise the objective chromaticity co-ordinates with tolerance area, a minimum value for the Duplication Index and a minimum value for the percentage luminance in spectral band No. 6. Alternatively, instead of the Duplication Index, the four Colour Contrast Factors with tolerances would be specified.

Reference

(1) C. W. Jerome and D. B. Judd—Specification of Color Rendering Properties of Fluorescent Lamps.
Paper read before the National Technical Conference of Illuminating Engineering Society (America), August, 1950.

SITUATIONS VACANT

The General Electric Co., Ltd., invites applications for the position of SENIOR LIGHTING ENGINEER at the Head Office in Calcutta of the G.E.C. of India, Ltd. Candidates must have had considerable experience of illuminating engineering, including decorative lighting. The upper age limit is 40 years. A substantial starting salary will be paid and the position is pensionable. Apply in writing giving full particulars of education, training, and experience to the Staff Manager, G.E.C., Magnet House, Kingsway, London, W.C.2.

LIGHTING SALES ENGINEER required for London area by electrical manufacturers E.L.M.A., E.L.F.A. members. National Certificate Elec. Eng. and electrical experience. Lighting knowledge necessary, I.E.S. Member preferred. Car driver essential. Salary, bonus, expenses. Pension scheme. Full particulars to Box No. 813.

REQUIRED: Back copies of the Transactions of the I.E.S. and "Light and Lighting" (formerly "The Illuminating Engineer") published before June, 1943. Offers to: R. W. Ames, c.o. "Light and Lighting."

I.E.S. ACTIVITIES

London

The March sessional meeting in London was a joint meeting with the Royal Institute of British Architects, the first such meeting since Grenfell Baines gave his paper in 1947. The paper on March 13 was by W. Allen and R. G. Hopkinson, both of the Building Research Station, and was entitled "The Lighting of Buildings"

Recent research on the lighting of buildings has been devoted to the lighting of the whole environment rather than that of the plane of the visual task alone. Progress has been made in the architectural field by trials of new designs to reduce harsh contrasts in the environment, without recourse to flat and uninspiring lighting. In the experimental field, studies have been made of the factors which influence glare, and of the methods which result in greatest visual comfort and efficiency.

The paper shows how the various computational approaches to the problems of lighting have influenced such matters as window design and town planning in the case of natural lighting and fittings design and the siting of fittings in the case of artificial lighting. The limitations of the computational approach are, however, not forgotten and considerable thought is being given to such problems as glare and brightness distribution and ratios.

The architectural and the experimental approach to the lighting problem have led to identical conclusions about the technique of good lighting. By good lighting the authors mean the most effective compromise between lighting that yields maximum visual performance, visual acuity, comfort, attention to the work or general overall brilliance; this compromise must depend upon the purpose of the lighting and the character of the building.

Arriving at this most effective compromise the following points have to be considered. (i) For maximum acuity the work should be the brightest part of the field of view and the surroundings should be only a little less bright; acuity is greater the brighter the task up to maximum daylight levels experienced outdoors. (ii) On the other hand for maximum comfort the work should be the brightest part of the field of view and the immediate surroundings should grade off into the general surroundings of lower brightness. There is a limit to the maximum task brightness for visual comfort. It may be of the order of 1-500 ft. lamberts. (iii) For maximum concentration the centre of interest should be bright, colourful and contrasting and the surroundings should be dark. (iv) For maximum overall brilliance there should be brilliant sources of light suitably placed in the field of view. These sources should be of low intensity (but high brightness) to avoid glare discomfort. Otherwise they should be graded into the background.

In general whereas in work places brilliance is not an essential feature of lighting, on the other hand drabness should be avoided. It is often a great advantage to have sparkle on the centre of interest for example, on machines this need for sparkle does not depend on the result of formal experimentation, but there is a great deal of circumstantial evidence for it and there is a persistent tradition throughout history. Totally indirect lighting of flat surfaces tends to be drab and soporific. Interest is aroused by variety in the brightness pattern. For this reason there is an advantage in a view of the lighting fittings and again for these to be of non-uniform brightness. Glare discomfort from the units can be avoided by the use of contrast grading in the design.

Birmingham Centre

At the sessional meeting of the Birmingham Centre on February 9, 1951, a paper was presented by Mr. E. W. Murrary, on "Lighting for the Prevention of Industrial Accidents." There were about 100 people present, including several nurses from local works, etc.

Mr. Murray opened by stating that the provision of "good seeing" is one of the most important items for securing better safety, health and welfare conditions. There were many accidents which one could assign to inadequate lighting and glare, but it was difficult to get corroborative evidence. It was not easy to overcome tradition and prejudice in the attitude that "it has always been done this way" or "everybody knew the area so well it did not need better illumination."

The Standards of Lighting Order No. 94

stipulated a minimum of 6 lm./sq. ft. over working areas, but it also says "sufficient and suitable" illumination must be provided. The only guides are the I.E.S. Code and experience, and we should endeavour to educate employers and operatives in the use of good seeing conditions. Points to be borne in mind are optium contrast at the working point, no tunnel effect, switch-points near to working positions, no distraction or inconvenience by direct or reflected glare. These remarks also apply to rough, unskilled work. The speaker stressed not only the adoption of the B.S.I. colour code for pipes, ducts, cables, gas cylinders, etc., but also mixed colour decoration for its psychological value. Matt colours should be used for the upper parts of walls to avoid disturbing reflections.

Another contributory factor towards accidents and inefficiency was abnormal and defective vision and operatives should be tested for colour-blindness, short sight and partial or total loss of the sight of one eye, as quite often they are unaware of their disability.

Side by side with good lighting should be visual aids for "very fine" seeing tasks. The speaker had known of cases where young people, selected for their good eyesight, had been used on "very fine" work, and after nine or 10 months had been found to have their sight seriously affected. In cases like these what was needed was a large-size magnifying glass so that both eyes could be used, or special bifocal magnifying spectacles suited to the particular person's eyes, plus plenty of the right sort of light.

There was a lively discussion, followed by a vote of thanks, proposed by Mr. R. A. Lovell and seconded by Mr. Paxton.

Glasgow Centre

In response to many requests and in an effort to spread as wide as possible the activities of the Glasgow Centre, the chairman, Mr. F. Dunnet, arranged a special extra sessional meeting of the Society on Thursday, February 22 last. The only hall available was thought to be too large, but over 350 electrical contractors and other interested persons, mostly, of course, outside the Society, attended the meeting.

Mr. C. J. King, of the Glasgow Lighting Service Bureau, spoke on "Fluorescent Lighting Circuits," and beginning his talk with a brilliant flash from an exploding lamp (running with no control gear) he continued with a description of the various circuits and components used. The final part of the talk was a demonstration of the many faults which can be diagnosed merely by observing the behaviour of the lamps.

A lively discussion took place, and it is felt that the activities of the Society will have been publicised by the evening's proceedings.

Manchester Centre

That the efficiency of a lighting scheme depends on the care taken in the design of the wiring installation as much as on the correct selection of the lighting fittings was the theme underlying the lecture given by Mr. F. Ainscow at the January meeting of the Manchester Centre. The meeting was held jointly with the Manchester Branch of the Electrical Contractors' Association, and it was appropriate that the speaker was a member of both bodies.

Mr. Ainscow gave a number of reasons to support his argument referring first to voltage drop, which he said might be sufficient to considerably reduce lamp efficiency, and he quoted the relationship between light output and voltage. Wiring systems were described and their particular advantages and disadvantages for lighting installations discussed. Mr. Ainscow then dealt with methods of switching and suggested that in any large lighting scheme there should, in effect, be three separate and distinct lighting installations with separate master control for each—general lighting, pilot lighting, and marginal lighting for areas where lighting is only occasionally required.

The lecture was followed by a very lively discussion in which lighting engineers and electrical contractors joined to exchange views on many of the points raised. The need for the observance of the I.E.E. Regulation calling for switches on different phases to be not less than 6 ft. apart gave rise to several comments as this affects the centralising of switches which was stressed in the lecture. Methods of wiring were discussed, as also were maintenance problems of lighting fittings and the desirability of using vitreous enamelled reflectors.

Mr. C. J. Fox, chairman of the Manchester Branch of the E.C.A., opened this discussion, and a vote of thanks was proposed by Mr. H. Hewitt, North Western Electricity Board, who asked for the co-operation of electrical contractors in trying to stop the indiscriminate use of unshielded fluorescent tubes fitted vertically in shop windows. These were not only examples of very bad lighting, but could be a serious danger to road users because of "disability glare."

Nottingham Centre

A most successful Ladies' Evening was held by the Nottingham Centre on February 9, when the principal guest was Sir Hubert Holdsworth, chairman of the East Midland Division of the National Coal Board. Sir Hubert paid warm tribute to the work of the Society, which was of great value to the community as a whole.

Mr. J. G. Holmes, a vice-president, replied to the toast, saying that the Society was a very happy one, its interests being cultural and technical but not commercial. He also referred to the part played by the Centres in the management of the Society, each Centre now being represented directly on the Council. The future of the Society, he said, depended on the enthusiasm of its members to see the Society flourish; there was at present no lack of enthusiasm, and whilst these conditions continued, he said, he had no doubts as to the future success of the Society.

Sheffield Centre

On Monday, February 5, the Sheffield Centre of the I.E.S. was honoured by a visit from the President of the Society, Mr. L. J. Davies, who gave his presidential address. He spoke of the great need for scientists with the inquiring mind, the need for co-ordination in research, and pointed out that it had become vitally necessary for the country, dependent as it is on its technical skill, to develop to the full discoveries and improvements in technique.

After an appreciation of the president's talk, Mr. J. A. Whitaker, Centre chairman, suggested that it might be useful to move to some extent the emphasis in research from the development of the fundamental discoveries of pure science to the problems to be found in the field of everyday application. Mr. Davies invited discussion at the termination of his address. Mr. B. Bingham said that he had listened with delighted interest to the talk, and that the president had no need to apologise for a "dry" subject, as he was sure that everyone present had enjoyed the talk.

Mr. W. G. Thompson also spoke of the work of the research pioneers, men like Faraday, Davy and Geissler; also in later years of the accidental discovery of stainless steel and the quick appreciation of its usefulness to industry. Mr. Thompson later proposed a hearty vote of thanks to the President, which was supported by Mr. H. B. Leighton. The meeting, which was well attended, closed at 7.30 p.m.

Forthcoming I.E.S. Meetings

LONDON

April 10th
Sessional Meeting. "Recent Developments in Gas Street Lighting," by P. Crawford Sugg. (At the Lighting Service Bureau, 2, Savoy Hill, W.C.2.) 6 p.m.

April 25th
Informal Meeting announced for this date has now been cancelled.

May 8th
Annual General Meeting followed by an address on "Luminescence," by Professor E. N. da C. Andrade. (At the Royal Institution, Albemarle Street, W.1.) 6 p.m.

May 9th
Annual Dinner-Dance. (At the Cafe Royal, Regent Street, W.1.) 6.30 p.m.

CENTRES AND GROUPS

April 2nd
Annual General Meeting, followed by film show. (At the Lighting Service Bureau, 24, Aire Street, Leeds, 1.) 7 p.m.

April 3rd
"Some Aspects of Illuminating Engineering," by W. R. Stevens. Followed by Annual General Meeting. (At the Medical Library, The University, Weston Bank, Sheffield, 10.) 6 p.m.

April 4th
"Colour and Lighting," by S. A. Wood. (At 4, Northampton Gardens, Swansea.) 5.45 p.m.

April 4th
Annual General Meeting, followed by a paper by G. Kingsley-Lark. (At the Minor Durrant Hall, Oxford Street, Newcastle-on-Tyne, 1.) 6.15 p.m.

April 5th
"Colour and Lighting," by S. A. Wood. (The South Wales Electricity Board, Demonstration Theatre, The Hayes, Cardiff.) 5.45 p.m.

April 5th
Brains Trust. (At the Demonstration Theatre, East Midlands Electricity Board, Leicester Sub-Area, Charles Street, Leicester.) 6.30 p.m.

April 6th
Luncheon and Presidential Address by L. J. Davies. (At the Grand Hotel, Bristol.)

April 6th
"Safety and Vision," by E. W. Murray. (At the Electricity Showrooms, Market Street, Huddersfield.) 7.15 p.m.

April 10th
"Lighting in the Pottery Industry," by H. Wade Harvey. (At 31, Kingsway, Stoke-on-Trent.) 6 p.m.

April 12th
Annual General Meeting, followed by "Home Lighting" by J. N. Aldington. (Joint Meeting with the E.A.W.) (At the Reynolds Hall, Manchester College of Technology, Sackville Street, Manchester, 1.) 6 p.m.

April 20th
Discussion—"Street Lighting," by E. Stroud and P. Crawford Sugg. (At the Imperial Hotel, Temple Street, Birmingham.) 6 p.m.

April 24th
"Scientific Relationship between Illumination and Photography," by L. A. K. Carr. (At the Lecture Theatre, Merseyside and North Wales Electricity Board's Service Centre, Whitechapel, Liverpool, 1.) 6 p.m.

April 26th
"Interior Decoration and Its Influence on Illumination," by S. A. Wood. (At the Gas Showrooms, Parliament Street, Nottingham.) 5.30 p.m.

May 10th
Annual General Meeting. (At the Demonstration Theatre, East Midlands Electricity Board, Leicester Sub-Area, Charles Street, Leicester.) 6.30 p.m.

POSTSCRIPT

By "Lumeritas"

Is there anything normally beneficent that some specimens of *homo sapiens* (?) cannot put to base use? One might suppose that light, at least, would be allowed to be only and always "a boon and a blessing to men." But no! Even light is pressed into service for "man's inhumanity to man." Excessive subjection to light is now a very important factor in bringing about the breakdown and securing the "confession" of political prisoners behind the "Iron Curtain." The principles of good lighting as a modern substitute for the rack and the thumb-screw appear to be quite simple, viz.: install glaring light sources; mount them in the central field of vision; and keep them blazing day and night.

From Hansard I see that the lighting of the Members' Lobby in the Palace of Westminster has come in for some criticism. The Minister of Works was recently asked to consider installing the brass chandeliers originally in Sir Christopher Wren's eighteenth-century House of Commons in place of the existing fluorescent lights in the Lobby. The Hon. Member who raised the matter said that at present the fluorescent lights in the Members' Lobby are so bright that there cannot be more than two (out of five) on at a time, so would it not be worth while considering putting in the more old-fashioned types of lighting instead? The Minister, in reply, said the reason only two of the fluorescent lights are now in use is in the interests of fuel economy; the old candelabra cannot be adapted for fluorescent lighting. Another Member asked the Minister if he is "still absolutely convinced that it is pleasant to sit under this beastly fluorescent lighting. Would not something in the nature of chandeliers be very much more easy on the eye?" To this Mr. Stokes replied, "Before the new Chamber was opened I had the lights completely changed round so as to improve the colour, and I think we had much better endure this a little longer and see how we get on." My own feeling is that the change to "improve" the colour has not done so, and that Members might have given the original colour a reasonable trial.

The "Accident Prevention Bulletin" for January, 1951, issued by the Minister for Labour and Industry and Social Welfare, N.S.W., contains a complete reprint of the text of a pamphlet entitled "Lighting and Seeing," which was first published by H.M.S.O. in 1943 for the Industrial Health Research Board of the Medical Research Council. I am told that this short war-time publication proved a best-seller when it was issued in this country, and it is interesting to find that it has been thought worth while now to include the text of it in an official publication issued "down under." The Commonwealth of Australia has its own lively Illuminating Engineering Society, whose Journal is the "I.E.S. Lighting Review." Also the Commonwealth Department of Labour and National Service has an Industrial Welfare Division which is keenly interested in factory lighting and visual problems in industry, and has recruited some of its technical staff who deal with these matters from the home country.

The correspondence continues in the daily Press regarding the visibility—or invisibility—of railway station name signs, and has drawn forth one or two defensive replies from the Railways Executive. I am bound to say that some recent journeys in the Midlands have convinced me that complaint is justified. In spite of careful looking—in day-time—I could find no name signs on some stations. The names of others appeared to be "Refreshments," "Way Out," and "Gentlemen." One, however, was labelled "Booking Office North," and here I alighted, as certain dingy landmarks enabled me to recognise it as my destination. This was in one of our largest cities and, before leaving the station, I took the trouble to inspect its 13 platforms and its main entrances to see if I could find the name by which I knew it in the year of grace B.B.R.2 (A.D. 1948). Believe it or not, my search was fruitless! I see Sir John Parsons, in a letter to the "Yorkshire Post," urges that, "Not only the colours but also the relative sizes of the letters for different-sized boards should be revised by a competent advisory committee, e.g., one appointed by the Illuminating Engineering Society, and it is eminently desirable that this should be done before the Festival of Britain." A rush job! But certainly something should be done speedily.